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- *OPEN QUESTIONS ON THE ORIGIN OF LIFE*
- *LITTLE ICE AGE, PART VIII: GEOLOGIC OBSERVATIONS*
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Haec Credimus

For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested on the seventh.—Exodus 20:11

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The Creation Research Society Is about Research

Since its inception in 1963, the purpose of the Creation Research Society has been to promote research in support of the biblical creation model. You are holding in your hands the most obvious manner in which we do this—publication of the *Creation Research Society Quarterly*. Two decades ago, we began publication of *Creation Matters*, a less technical journal. We also maintain our website (https://www.creationresearch.org/), where we have posted many articles. But there are other ways in which we promote creation research. A few years ago we began our regular (nearly) annual meetings, where members have the opportunity to share their latest work and interact with fellow creationists. Our meetings have steadily grown in attendance, and we expect they will continue to do so. Our next meeting is scheduled in Ann Arbor, Michigan, July 28–30, 2016.

Perhaps our best-known recent effort in promoting creation research is the iDINO (Investigation of Dinosaur Intact Natural Osteo-tissue) project, which was the subject of our special spring issue of the *Creation Research Society Quarterly*. This research was funded by donations to the iDINO fund. Many of these donations came from Society members. The iDINO project has been the most robust research on preserved soft tissues of dinosaurs conducted by biblical creationists. By the way, we printed a large number of extra copies of our special spring iDINO issue. Society members can purchase these extra copies for $5 each. Many members have found that this is a valuable publication to hand out to other creationists or even to skeptics or people not familiar with the CRS or biblical creation.

However, iDINO has not ended. The Society is now raising funds for iDINO II, to take original research of preserved soft tissues of dinosaurs (and possibly other creatures) to an entirely new level. Many Society members who are not scientists and hence do not think they can meaningfully contribute to creation research by their activities certainly can contribute to this important work with their donations. As always, all donations to the Society are tax-deductible.

There are other ways that members may actively participate in research. Many of our members may not know that the Society has funds available for research grants. These grants are competitive, so there is no guarantee any particular project will be funded, but you will never receive a research grant if you do not apply. Beyond Society membership, all that is required is a brief description of the proposed research, a resume for each principal researcher, and a proposed budget. Oh, and we expect that you submit your completed work for publication in the *Creation Research Society Quarterly*. Also, it would be great to present some preliminary results of funded research at an upcoming Society meeting. Get more details at our website: https://www.creationresearch.org/index.php/research/research-grants

Danny R. Faulkner
Editor
Creation Research
Society Quarterly

Creation Research Society Quarterly 2015. 52:85–94.

Random Retinal Imagery

David E. Stoltzmann*

Abstract

In an earlier paper, the statistical case was made for the impossibility of the human visual system (eye and brain) to have organized itself by random-chance evolutionary processes. The "data connections" between the eye's retina and the brain that must be correctly correlated in order to produce an excellent image of a scene require a Designer to implement a system that obeys the laws of optics for correct object-image mapping. This paper builds on that earlier paper to illustrate randomly generated imagery for a number of object scenes, including randomness levels from 0% to 100%, and draws some conclusions about what we should be seeing with our visual system if evolutionary processes were the creative agent. God has provided the human stereo visual system, along with millions of other created visual systems in nature, to offer His testimony of miraculous Creation.

Introduction

A decade ago the author presented a statistical basis for the conclusion that random-chance evolutionary processes cannot possibly account for the image formation and the image sampling that takes place in the human visual system (Stoltzmann, 2006). The object-image mapping process that the eye and brain accomplish involves millions of retinal receptors that must be "wired" correctly in order for excellent vision to take place, and no random process can accomplish this task. To investigate this further, this paper presents simulated imagery in various stages of randomness to illustrate what level of image quality we could expect to witness if our visual system were randomly assembled.

In 2005 the author presented a paper to the International Society for Optics and Photonics (formerly known as the Society of Photo-optical Instrumentation Engineers, or SPIE) detailing the statistics of randomly assembled visual systems (Stoltzmann, 2005), and the results of that paper were later published in the *Creation Research Society Quarterly* (CRSQ; Stoltzmann, 2006). An evolutionist at this conference was quite displeased with the presentation and told the author, "We get the correct wiring for the eye at birth, and that was all that was needed to be said about the subject." This testifies to the closed-minded nature of even the most educated people who are involved with detailed research, when God is rejected outright and only natural processes are allowed to offer answers. Over the past decade, the original SPIE paper and the CRSQ paper have been offered to many evolutionary-minded people, asking each of them to refute the statistics and the mathematics presented in the paper. None have done that, although many evolutionary sermons have been preached in lieu of a refutation being given. The simple conclusion is that the

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best evolutionary scientists cannot offer an explanation of how the visual system gets mapped and interpreted correctly in the brain, supposedly by chance.

Investigating Random Imagery

To begin, let us take a look at Figure 1 from the decade-old SPIE article (Stoltzmann, 2005), which is also Figure 2 of the CRSQ article (Stoltzmann, 2006). Figure 1(b) shows one of the 2500 factorial ($2500! = 10^{7,411}$) possible rearrangements or permutations of the 50 by 50 pixel array that represents the object scene of Figure 1(a), namely a small portion of a topo map.

A colleague (see acknowledgments) wrote a computer program that will take a digital image and process that image to randomize the pixels such that any level of randomization can be selected by the user. The process simply applies a random generator function to the array of pixels in an image and relocates a user-specified level of pixels (0–100%) to other parts of the image, randomly, while putting the replaced pixel contents in the place where the original pixel was before randomization. There is no "noise" being introduced, even though the gray-scale images in this paper appear to have noise as a result. Applying that program to the image of Figure 1(a), the randomized images of Figure 2 are obtained when the level of randomization is selected, in this case to range from 50% to 99%. At approximately 80% randomization, a faint "Well" and "22" can still be seen as almost "ghost details" hidden within a background of noise. Randomization levels higher than 80% yield essentially images of complete noise where none of the original image detail can be discerned.

Some Statistics

In the 2006 CRSQ paper, the statistics showed that for the retina to have a large number of correctly connected rods and cones (i.e., these receptors are correctly mapped in the sense that a camera lens does this same function), the result for random connections is that the percentage of correct connections diminishes rapidly as the desired number of correct connections (M) increases (Stoltzmann, 2006). The percentage of correctly connected receptors is given by: 36.78794/M! percent. As M increases, M! (M factorial) in the denominator increases exponentially, resulting in a pixilated field of view (FOV) wherein very few of the pixels are correctly wired. No matter how many pixels or receptors there are in the FOV, the percentage of correctly connected pixels remains fixed at 36.78794/M! percent. For a large number of pixels, the net result is that there are possibly a few correctly connected pixels, but they are lost within a huge ocean of incorrect connections. The visual system ultimately cannot tell which pixels are correctly wired and which are not, because the image looks like noise for the most part. This is what is illustrated at about the 80% randomization level shown in the images of Figure 2.

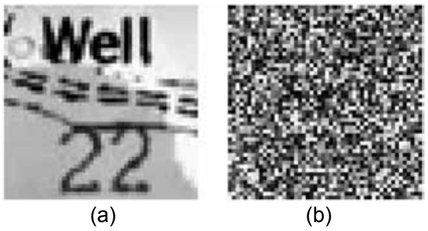


Figure 1. 50 x 50-pixel image of a small section of a topographic map. The correctly digitized (scanned) image is shown in (a), while the scrambled pixels shown in (b) represent one redistribution of the 2500! ($1.63x10^{7411}$) possible permutations of the pixels for this image. 50 x 50 pixels is roughly 1/6th of the foveal FOV for human eyes.

An 80% randomization level might seem like a huge "penalty" to the image, wherein 4/5 of the image is degraded by the randomization process. The previous papers showed that regardless of the number of pixels in a given FOV,

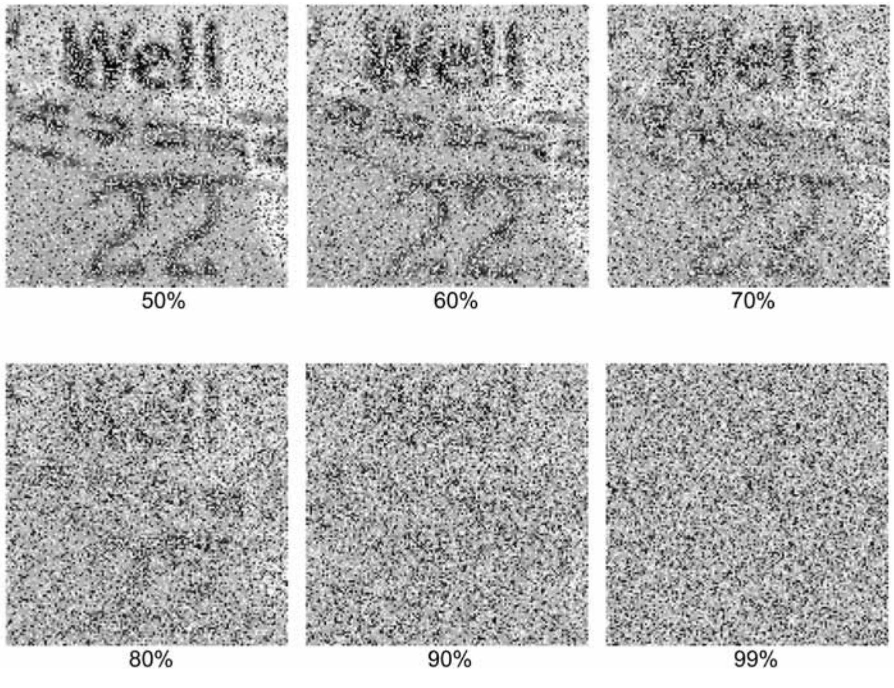


Figure 2. The pixels of Fig 1(a) have been randomized at various levels, indicated by the percentages.

if the requirement is arbitrarily that 6 or more pixels are needed to be mapped correctly, 99.9% of all the combinations of random connections are incorrect wirings, and less than 0.1% of the random wiring attempts will have 6 or more pixels connected correctly (Stoltzmann, 2005, 2006). This is a staggering concept for random-chance image formation in an eye or visual system. If the various images of Figure 2 were to represent the fovea of the human visual system, there would be approximately 125 x 125 pixels in the images, or about 15,000 total pixels, and 99.9% of the rearrangements of these 15,000 pixels will deliver fewer than 6 pixels that are correctly connected, compared to the Figure 2 example of 80% incorrectly connected pixels and 20% (3000 pixels) correctly connected. Yet an 80% randomization level appears to look like noise across the full FOV. The simple conclusion is that asking for only 20% of the visual field to be mapped or connected correctly is completely impossible by random chance, and in reality less than 0.1% of the time we will get 6 or more pixels having correct connections. Random chance will give an image not unlike what is shown for the 99% randomization image of Figure 2; that is, complete noise with no detail at all.

This conclusion can be framed another way. One (1) of the large set of 100% randomized images will look exactly like the original image, and the challenge for evolution is for the visual system to assemble that one (1) perfect image, just like what normal humans see every day. For the 50 x 50 pixel array of Figure 1(a), evolution will have to try 2500! permutations, or $10^{7,411}$ possibilities. And this is just 1/6 of the foveal FOV, which is not even close to the 126 million rods and cones that have to be correctly connected. If the number of pixels were only 12 (a simple 3 x 4 array), evolution "only" has to try 12 factorial (12! = 479,001,600) possibilities to get a perfect image. That is, evolution has to try half a billion attempts to get 12 simple pixels wired correctly. This is the problem evolution has to somehow overcome to obtain the human visual system, using only random changes to the retinal makeup. Evolution just cannot work with this kind of complexity.

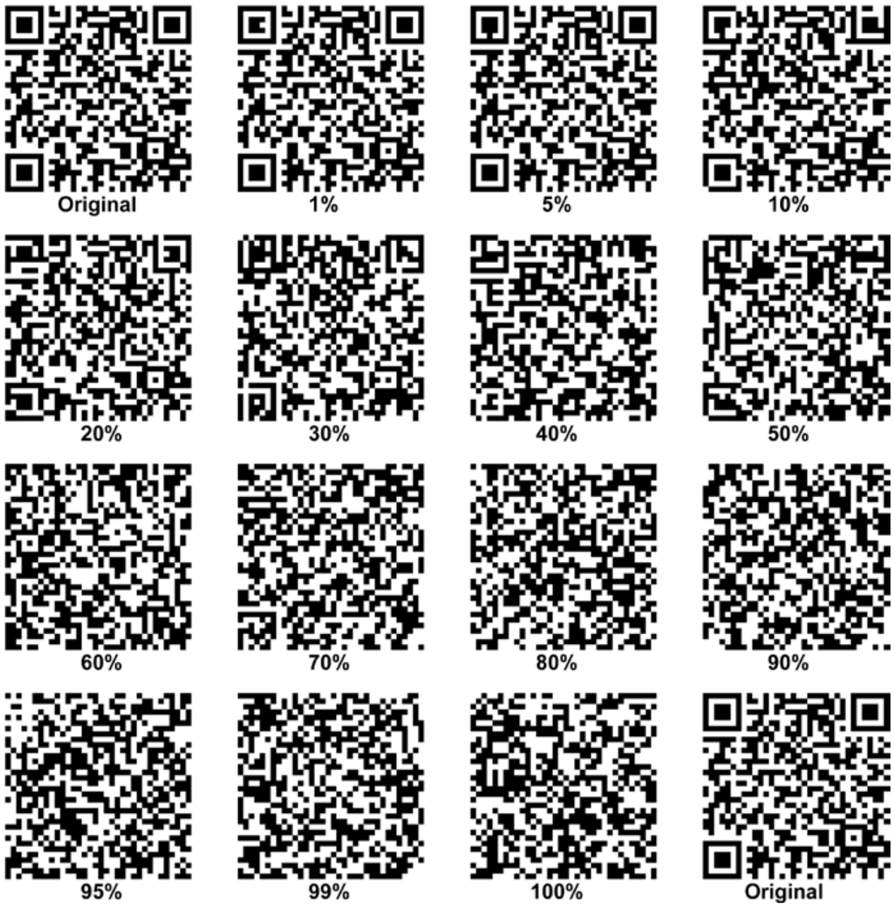
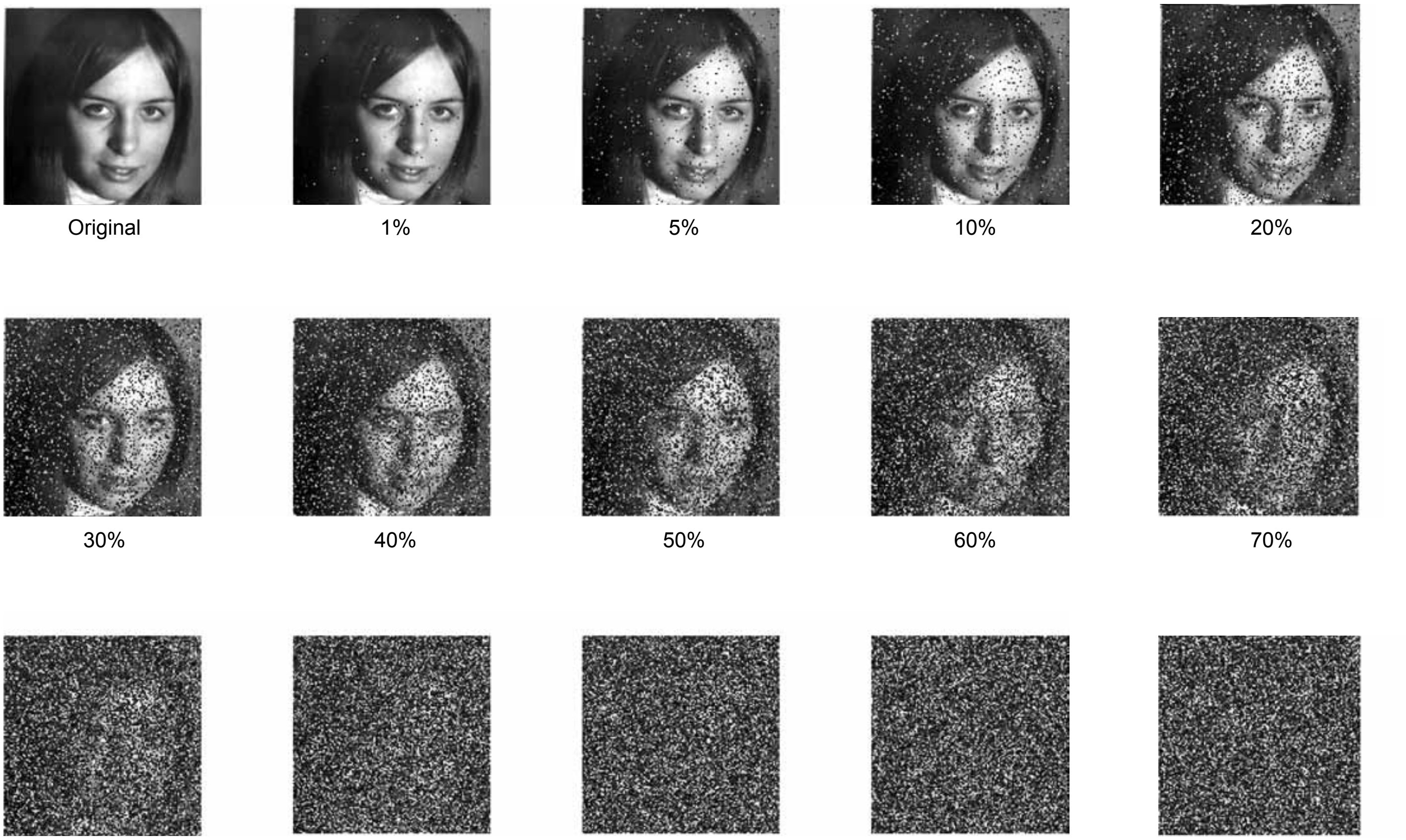


Figure 3. A 2D (2-dimensional) barcode pattern with 34 x 34 pixels is shown in various stages of randomization. At levels above 50% randomization, almost all of the three corner-orientation squares are lost for this approximate QR code example of a barcode.

As another example of randomized imagery, Figure 3 examines the visual appearance of a 2D (two-dimensional) barcode array, often referred to as a QR code, with its three corners of squares used for orientation and alignment. The individual images in Figure 3 have 34 x 34 pixels, and the images are binary in the sense that either a pixel is completely black or completely white. As the randomization progresses from 0% to 100%, the number of black pixels and white pixels remains the same, and the images still resemble barcodes, but the thing to notice is how the original information for the three alignment squares disappears with increased randomization. At a randomization level of 50% or higher, the squares are lost in the scrambled array of pixels.

Noise in the Image

Some interesting artifacts appear when randomization is applied to a normal photograph of a face. Figure 4 illustrates that even with low randomization levels, noise in the image appears and is visually disturbing. Above 80% randomization all details of the face are lost in the noise,



Original 1% 5% 10% 20%

30% 40% 50% 60% 70%

80% 90% 95% 99% 100%

Figure 4. An actual photo of a face is used as the image, which gets degraded by increasing levels of randomization. In evolutionary terms, one could consider this an example of what a "primitive" eye-brain visual system might deliver if not all of the rods and cones are hooked up correctly. Each image is represented by 125 x 125 pixels, similar to the ~15,000 photoreceptors of the human fovea. Above 80% randomization, nothing in the FOV is discernable as detail. Random-chance connections would deliver imagery somewhere between the images represented by the 99% and 100% randomization levels.

but even at 5–10% randomization the noise is pronounced. One might ask how evolutionary processes have eliminated the noise even in the low randomization images? That is, why is there no additional random noise to remove from the human visual system when random processes are the only ones allowed to be used to even get an image? How has evolution been able to perfectly "peak" the visual system and leave no noise?

The use of the word "noise" in this paper should be clarified. Visually, the randomization process for altering the images appears to inject "noise" into the image, in the case of gray-scale or color images. In fact, there is no noise being introduced, but rather a reassignment of some of the original pixels to other locations in the image. Even though the reassigned pixels appear to be out of place and appear visually like noise, in fact their gray-scale or color content has been preserved, and only the locations of the random pixels have been changed. In the case of a video presentation of the randomly reordered pixels, a "fixed-pattern noise" appears to be evident in the altered video, and this pattern can be observed to track with the panning motion of the camera, indicating that each frame of the video has the same random change applied to it rather than some true random "noise" ending up within each video frame.

Troubles for Evolution

Noise in a visual image is a real problem for evolution. If the human visual system had noisy imagery as a result of evolution still trying to "work" with the natural selection process to improve the images, that would be a very powerful claim that evolution has developed the visual system. But those random connections that are incorrect and produce the noise are not to be found with the normal human visual system. That seals the case for creation and a God who has designed the visual system to be very pleasing to the sighted human being. If the visual system had arbitrarily about 10% randomization errors, that imagery would not preclude humans from hunting/gathering or living a full life with "slightly" degraded eyesight. So why has evolution not left us with less than perfect vision? What makes random chance so powerful with its claimed ability to create incredibly peaked living organisms? The simple answer is that God must provide the miracle of life and the information that peaks the living matter of His creation. And in the end, if evolution is still working on removing the final 10% randomization in this example we have been discussing, how does further random alteration of the 10% degraded imagery remove the incorrectly wired pixels and not alter the good pixels instead? Natural selection provides no guarantee that altering a given system will improve the results, and that certainly is the case when it comes to the wiring of the eye-brain system. If you doubt this, just try randomly altering your TV screen pixels, or your digital camera pixels, and see if you can improve the imagery.

As another example of noise in an image from miswirings, Figure 5 presents randomized images of text, where there are initially individual regions of black and white pixels that get increasingly scrambled. The selected text is Figure 9 and its caption from the original SPIE paper (Stoltzmann, 2005). Such imagery is very unforgiving when it comes to having noise in the image caused by incorrect wirings. Even though some text can be discerned at the 80% randomization level, the random noise dominates the imagery. At a 10% level or higher there is ample noise showing up, testifying that our visual system is not plagued with such randomization errors.

Figures 4 and 5 clearly address a substantial problem with evolutionary processes. Two human eyes represent an almost perfect object-to-image mapping, where each rod and cone is wired correctly in each eye, and the stereo overlap of the imagery from both eyes is perfectly matched too. A normal human visual system does not show the "background noise" that Figures 4 and 5 depict, where some of the eye-to-brain connections are incorrect. For example, when viewing a brightly lit TV screen in a dimly lit room, we do not experience a random-noise background around the periphery of the TV screen, caused by incorrectly wired receptors. Even a few percent of image randomness would be perceptible, and quite annoying. So, how could random-chance, purposeless, undirected processes have created a visual system that shows no such random wiring errors? If evolution were true, we would expect that some level of random noise would be seen, not unlike looking through a somewhat dirty window. But what the actual human visual system provides with each eye is a noise-free view of the world, an incredible concept in and of itself, considering all of the connections involved.

A "Very Good" Visual System

Our visual system is not randomly assembled in some long, drawn-out, trial-and-error process of natural selection. It shows full evidence of a Creator who pronounced His creation "very good" (Genesis 1:31). No consumer would purchase a digital camera that had 10% randomly and incorrectly connected pixels in the imagery produced by the camera, and that consumer would certainly not pronounce that camera "very good." Only God can program our DNA to allow for a "very good" visual system to speak to His creative powers. We live in a time where such scientific evidence abounds in every field, and we are definitely without excuse in this regard. The human visual system alone should be all that is needed to convince an open mind willing to listen to the evidence. Even Darwin contemplated the extreme difficulties associated with the human visual system, but he still argued that given enough time and enough small perturbations, an eye could have developed gradually to be what we have today with the visual system. Darwin did not address the complexities involved with the "wiring" of the visual system, and well over a century later evolutionists still do not have an explanation for how the 126 million rods and cones of a single eye are correctly connected to the brain.

The simplistic evolutionary statements that a single eye spot eventually turns into two eye spots, and then more eye spots, to eventually develop into a complex retina, do not convince anyone of the truth of that claimed process. The message is clear from the statistics of random wiring of a visual system: It is absolutely impossible to produce any meaningful level of correct connections in the visual system by random chance. As the original SPIE paper (Stoltzmann, 2005) illustrated a decade ago, in any image, getting more than say 6 correct connections (pixels or rods or cones) leaves 99.9% of the rest of the attempts at 6 correct connections as incorrectly connected images. Even the 99% randomized images shown in the previous figures do not come close to representing the level of incorrect connections from random processes. 6 pixels out of the 570,000 pixels that make up the images of Figure 5 represent 0.001% of the FOV, and it would be impossible to find those 6 pixels in the noise of incorrectly connected pixels. To any evolutionist who is still unconvinced, the challenge is to demonstrate how random processes can achieve perfect vision, first in one eye, and then with two eyes that have perfectly correlated FOVs for stereovision. This very question has been posed to many evolutionists over the past decade since the SPIE and the

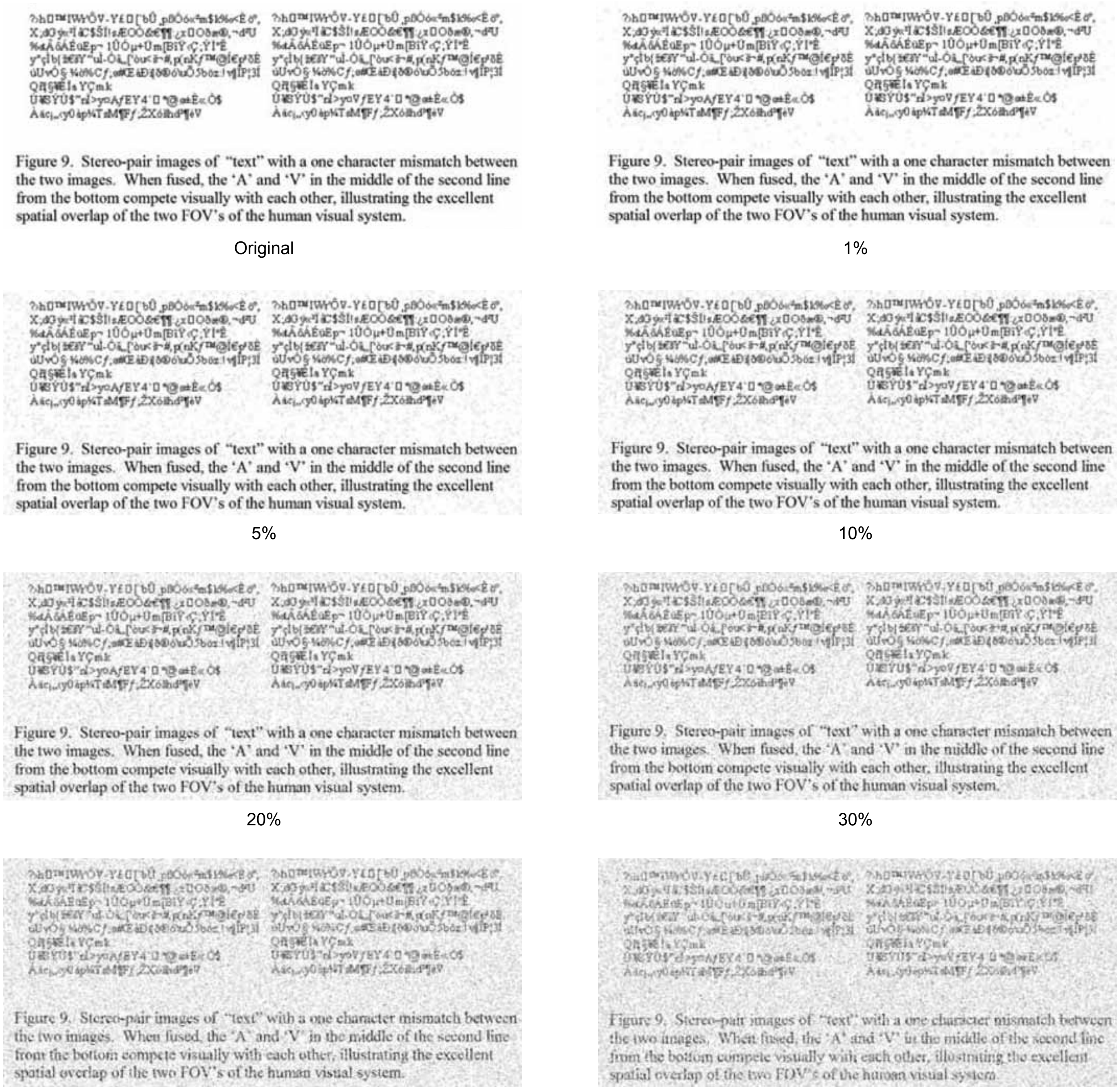


Figure 9. Stereo-pair images of "text" with a one character mismatch between the two images. When fused, the 'A' and 'V' in the middle of the second line from the bottom compete visually with each other, illustrating the excellent spatial overlap of the two FOV's of the human visual system.

Original

1%

5%

10%

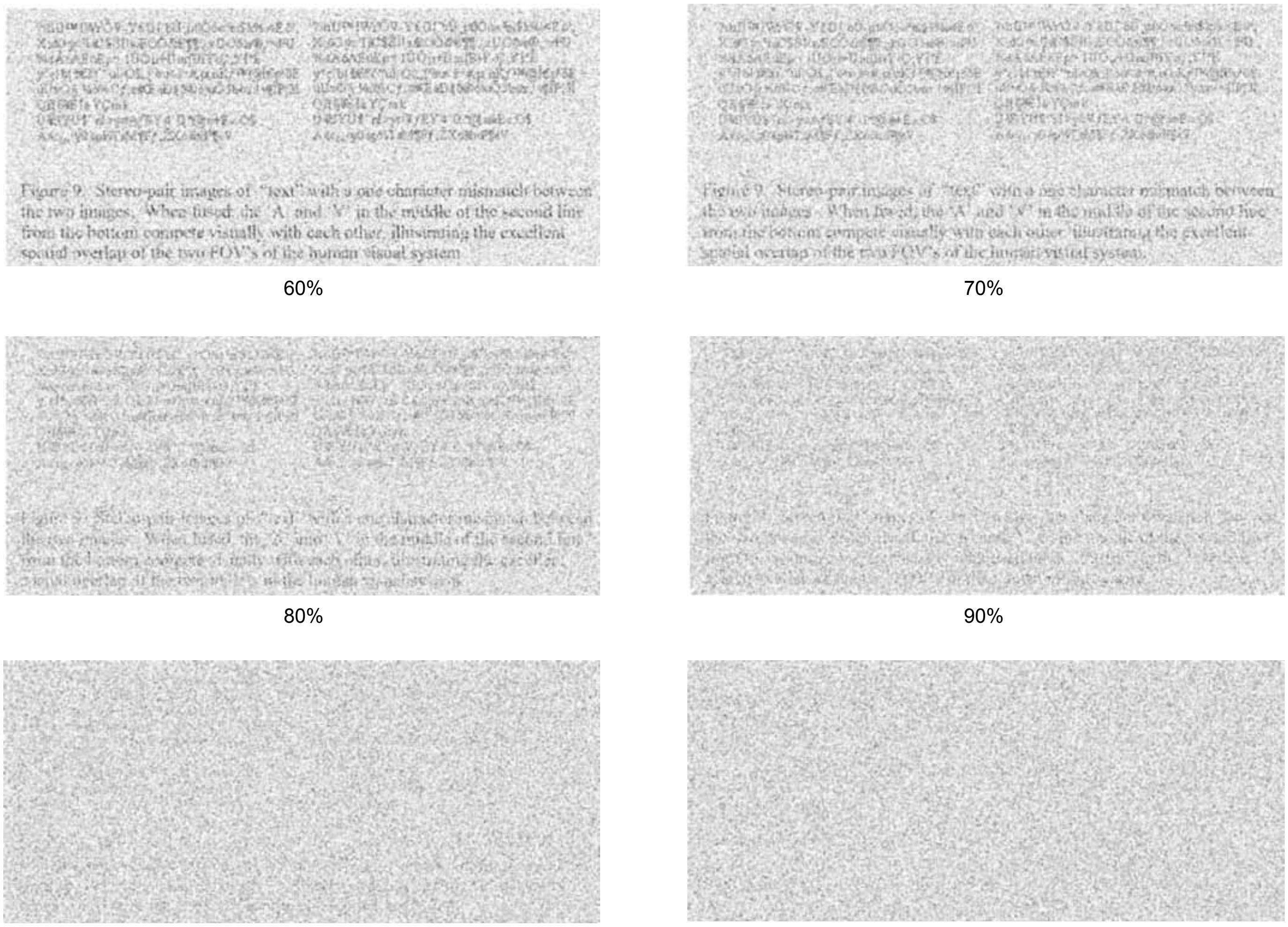
20%

30%

40%

50%

Figure 5. A larger FOV (1140H x 500V Pixels, or about 36 times the area of the fovea) is depicted with increasing levels of randomization. Figure 9 from the SPIE paper (Stoltzmann, 2005) was used as the text image for randomization. Note how even with a few percent of the image being randomized, background noise shows up in the formerly clear portions of the image. The main reason some faint text can still be discerned in the 80% randomization level image is because of the greater number of pixels used (a higher sampling level of the image) in this example (1140 x 500 instead of 125 x 125 or 50 x 50 used in previous figures).



60%

70%

80%

90%

95%

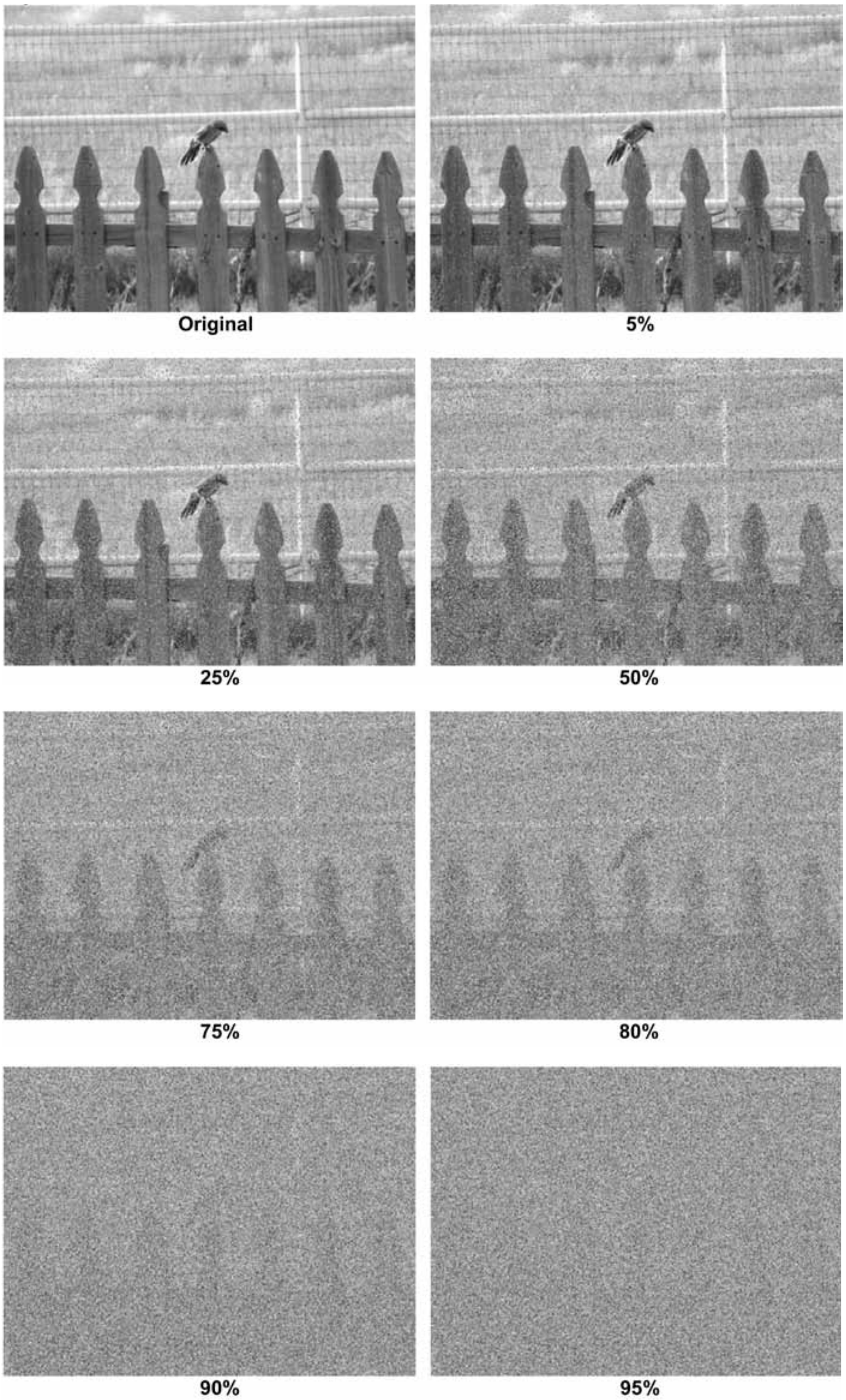
99%

Figure 5 (continued)

CRSQ papers were published, but no evolutionist has offered a cogent answer or a detailed example. For those skeptical of this claim, just try to wire a 125 x 125 pixel "approximate fovea" digital camera (a 1/64th megapixel camera) by random processes, and then show everyone the details of how that random process can achieve a perfect match for the pixels. For this case, where there are about 15,000 pixels, the number of combinations (15,000! = 2.75 x $10^{56,129}$) is such a huge number, no person can comprehend it.

All Creation Is "Peaked"

While we are mainly presenting our analysis for the human visual system here in this paper, all of creation speaks to the same fundamental principle; namely, that each living organism is uniquely and perfectly adapted to its environment with all of its created features. The evolutionary videos we all have seen on TV speak to the incredible abilities of the creature being featured, "almost" as if these features were designed. But ask yourself how every living creature shows evidence of perfection in how it lives and functions. Where is the evidence for non-peaked creatures that evolution is still working on to improve the performance in some manner? Random processes should only produce "goo," if even that, so where is the goo that evolution is working on to turn into an ever-increasingly complex living creature? Why is every living creature peaked? How has evolution managed to peak the visual systems of millions of sighted species on the planet? Evolutionists, please show us a plausible scenario where randomness creates perfection in an image-forming system.



Original
5%
25%
50%
75%
80%
90%
95%

Figure 6. A VGA (640 x 480 pixels) format image of a bird sitting on top of a picket fence, with a finer grid white fence in the background. The fine-scale details vanish more quickly with increased randomization of the image. Little of the fine-grid detail of the white fence remains in the 50% image, while some of the predominately vertical detail of the dark picket fence and the bird remains at the 90% level. The color videos can be found on YouTube by searching for: "oemspectrastudios".

Randomized Video

As another visual depiction of a random process working on an image-forming system, we have taken a VGA format (640 x 480 pixels) color digital camera and photographed a simple scene with a moving object, in this case a bird hopping on a fence (see Figure 6). This could be thought of as a primitive eye's view of a scene where a human is trying to hunt for food. The randomization level was arbitrarily set at 50% for this video imagery, to illustrate what we could expect for quality in the final imagery at this level of randomness. Note that while this video clip is in color, little of the RGB (Red, Green, Blue) color fidelity is left intact with the 50% randomness-level imagery. Rather, the color is washed out even though 50% of the pixels are wired correctly. One has to wonder what the improvement is to such a colored scene as viewed with this level of degradation to the eye. How would a primitive eye be able to develop a color image capability in the first place, given the washed-out nature of the degraded imagery present in images like those presented in the video? Not only is it impossible for the wiring of the visual receptors to be correctly obtained by random evolutionary processes, but color vision further demands that the visual system successfully samples the visual spectrum (blue to red wavelengths) with color receptors, as well as sensitive rod (black & white) receptors for enhanced night-vision capabilities. Color receptors seem to add little if any visual improvement to the imagery at randomness levels at or above 50%, so how does natural selection work to improve such color imagery in the eye? Unless very little randomness already exists in the imagery, a degraded color image functions about the same as a degraded black and white image. Every time we examine the visual system with greater depth, more problematic issues arise that defy evolutionary answers.

The color video of the original scene (with no randomness applied to the images), as well as the 50% randomness scene video can be located at the author's YouTube website (https://www.youtube.com/playlist?list=PL8nzsFI8ARgjZeIXWgWIahm3hcSCJFdHV), or by searching YouTube for: "oemspectrastudios." In the 50% randomized video of the hopping bird, note how the fine structure of the feathers in the wings is lost in the noise, as is all of the detail in the head and beak area. When half of the visual field is randomly miswired, the visual results are devastating to the image quality, especially with the fine details. Note how all the black nail heads near the top of the fence disappear completely in the degraded image. How can natural selection work on such a degraded image, improve the visual performance, and still maintain the 50% of the image that is correctly wired? How can any random process figure this out? If we were to present this set of 640 x 480, 50% randomized pixels to an electrical engineer skilled in camera architecture and image processing, that person with all the complex tools available today could not remap the image to the correct state. One would have to know precisely how the random pixels are miswired in order to reconnect them correctly. Natural selection has no ability to tackle this formidable task, nor does the electrical engineer.

Figure 6 presents several black-and-white randomized images for the color visual scene depicted in the video clip, where a bird is perched on a picket fence, with a wireframe white fence in the distant background. This visual scene contains lots of information content that can be visually analyzed as the randomness in the image is varied. For example, the bird subtends a reasonable angular size to the visual system, about 50 feet away from the observer, even though the bird represents a relatively small part of the FOV. The wooden picket fence the bird sits on is relatively dark overall, has large horizontal and vertical features associated with the wooden planks, and can be contrasted with the thin grid of rectangular wires on the distant white fence in the background. So the visual details span a large range in terms of size and grayscale. The visual degradation caused by the random noise affects each of these visual details differently, and generally only the largest visual objects remain visible, albeit with lots of noise affecting even them.

Figure 7 presents three different visual scenes in black and white (color versions are online at: https://oemspectrastudios.imgur.com/), where the original scene is shown first, followed by a 50% randomly degraded scene. Coarse details (larger objects and features) remain, although degraded, in the randomized images, while lots of noise appears in the background of all of the randomized images. In the color images, the color saturation level, as well as the size of the colored object, affects the visual system's ability to discern the true nature of the objects being viewed. The 50% randomization level was chosen for these examples so that the reader can actually see the degradation done to variously sized objects in the FOV, because higher levels of randomization would blend all the colors into a uniform visual scene of basically one color determined by the original content of the RGB pixels in the true scene. If we were to ask for only 6 pixels in these VGA (640 x 480) scenes to be mapped correctly, that involves only 0.002% of this visual scene, leaving 99.998% of the scene as random information. At this level, all color information is lost as colored noise, and the color information provides no additional help to the visual system for image fidelity. The previous papers showed that if only one (1) pixel is to be correctly located (mapped) in these images by random processes, it would mean that 36.8% of the time that will occur and 63.2% of the time a single pixel would not be correctly located. For two correctly located pixels, it will occur 18.4% of the time, and 81.6% of the time randomization will not obtain the two correctly mapped pixels. For six pixels, 0.05% of the time six pixels will be mapped correctly, and 99.95% of the time they will not. To obtain one half of the pixels correctly mapped, as is the case in the (b) images of Figure 7, where half of the 307,200 pixels are correctly mapped, this condition will not happen in the lifetime of the universe regardless of how that is defined. So even the severely degraded images of Figure 7 at the 50% randomization level represent a "superb" image by random processes. Neither color nor black-and-white images will ever achieve the 50% correct-connection level by evolutionary processes.

Summary

The theory of evolution would have a very powerful testimonial argument if the visual systems of living things still showed evidence of randomness in the perceived imagery. That could mean that natural selection might still be working on the visual system to further improve the image quality. But this paper shows that visual systems like the human eye-brain complex show no evidence of random incorrect connections of the visual pathways from the eye to the brain. Our visual system is peaked in terms of performance that obeys the simplest optical law of object-image mapping, that is, the object scene is uniquely mapped to the image as simply as the imaging operation performed by a pinhole camera. The statistics involved with obtaining this correctly wired visual system prove that the wiring has to be a designed feature of our DNA, and not something that can be achieved by random processes. A photograph of a human face being viewed

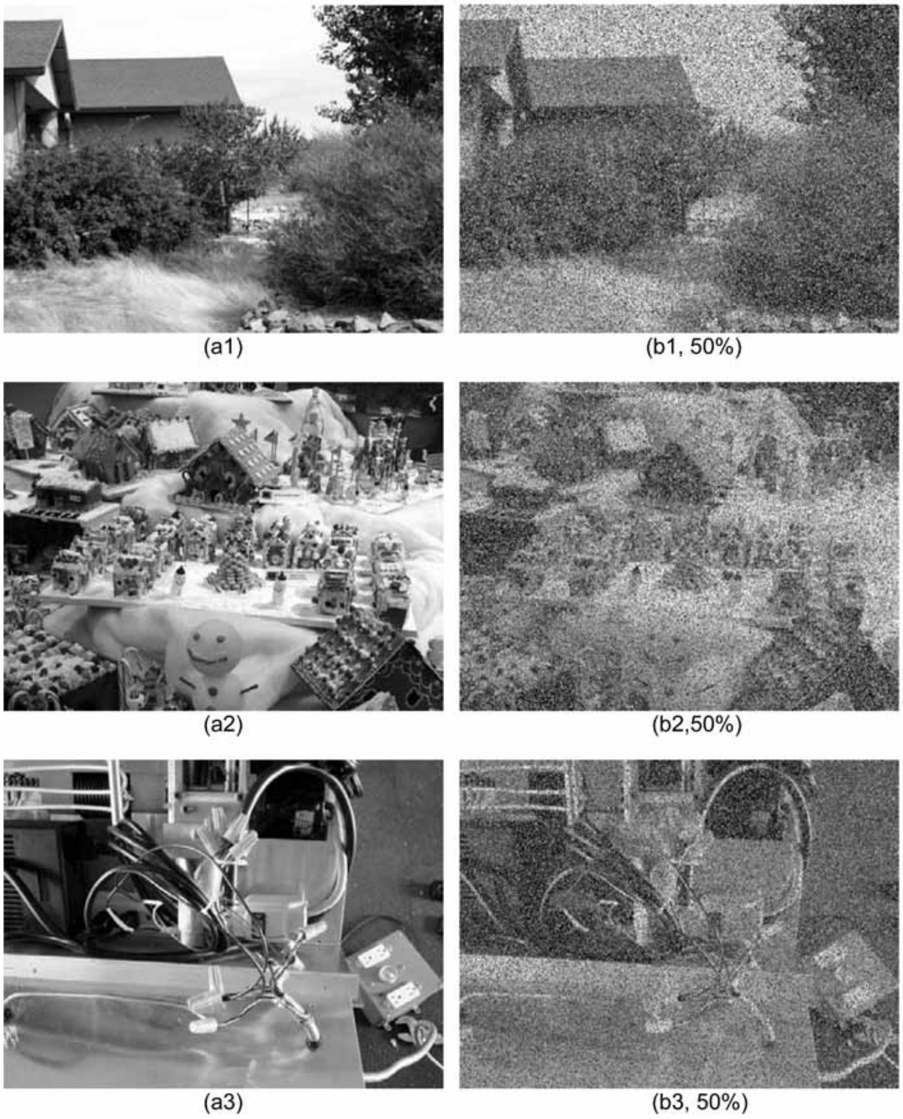


Figure 7. Black and White versions of three visual scenes (the color versions are online at: https://oemspectrastudios.imgur.com/), where the originals are a1, a2, and a3, and a 50% randomization level has been applied in b1, b2, and b3. In a1 the house scene has a small tree located in the center of the field, which is purple in the color image (online), and that tree gets quite degraded at the 50% randomization level with all the noise that populates the randomized image in b1. Similar degradations are evidenced with the gingerbread village of b2 and the electrical wiring image of b3. The color images online illustrate that the color saturation level of the various objects in the visual scene, as well as the size of those objects, all affect the perception of color after randomization is applied.

by a human eye shows no randomly incorrect wirings, or noise, in the image, as illustrated in Figure 4, and the other examples of visual scenes presented in the other figures further bear witness to our visual system, which has been pronounced to be "very good" by our Creator.

Evolutionists have it easy in the sense that clever stories can be told about some complex living process, where if one waits long enough with sufficient perturbations being applied during the process, wonderfully functioning life-forms arise to populate the planet. Our analysis for the human visual system shows such stories to be completely inadequate to describe how our visual system came into being. Random processes working on the visual system will produce only noise in the resultant imagery, and nothing useful would ever be seen by the sighted creature. Our Creator has allowed us to live today in a very advanced technological age, which also allows us to scientifically probe the very fabric of our creation. We are fearfully and wonderfully made in the image of God, and one would have to be blind to the facts to trust evolutionary stories.

Acknowledgments

I wish to gratefully acknowledge the work of Jeff Setterholm and his computer programming skills. Jeff wrote and compiled an executable program that takes an input digital image and randomizes that image to any specified level set by the user. This program was used to create the degraded images contained within the figures of this paper. I also wish to gratefully acknowledge the work of Brock Stoltzmann and his image processing skills, which helped to create the video segments referred to in the paper.

References

Stoltzmann, David E. 2005. Image formation in the eye: very specified complexity. *Proceedings of SPIE*, Volume 5866: *The Nature of Light: What is a Photon?* 321–331.

Stoltzmann, David E. 2006. The specified complexity of retinal imagery. *Creation Research Society Quarterly* 43:4–12.

Creation Research Society Quarterly 2015. 52:95–105.

Cyclostratigraphy

Part I: What Is Cyclostratigraphy?

John K. Reed and Michael J. Oard*

Abstract

Stratigraphy has undergone dramatic changes. From a simple timescale resting on paleontology and relatively few and less precise radiometric dates, it has become an integrated, sophisticated discipline built around a timescale that is increasingly complex and supported by new and equally complex methods. Creationists must understand and address these changes, especially those changes in the methods. This series will focus on one of the newer methods: cyclostratigraphy and its associated astrochronology. Cyclostratigraphy links various properties of sedimentary rocks to an astronomical "clock" based on the extrapolation of orbital mechanics into the past. This clock sends a signal of varying sunlight to Earth, manifested as "Milankovitch cycles," that are thought to force climate change sufficient to be recorded in sedimentary rocks.

Introduction

Torrens (2002, p. 251) stated: "The science of geology is all about time." He said that stratigraphy is "the only area of geology that is truly unique, other branches of geology are too often borrowed bits of physics, chemistry, or biology." But secular geology as a historical discipline rejects biblical history, and through its aura of "science" has led many Christians to accept deep time. Creationist pioneers knew they needed to address deep time as well as evolution, which meant discrediting, at a minimum, the geochronologic timescale and its supporting methods. In the 1960s and 1970s, these were predominantly evolutionary biostratigraphy and radiometric dating. Gish (1972) noted weaknesses in biostratigraphy—field exceptions that included "living fossils," the imprecise ranges of many taxa, and circular reasoning. Others began to address problems with isotopic techniques (Gentry, 1966; Whitelaw, 1968, 1970; Woodmorappe, 1979).

Creationism became a robust scientific Christian response to secular geology not seen since the nineteenth-century scriptural geologists (Mortenson, 2004). This coincided with a revolution in geologic thought driven by an explosion in the exploration of the deep oceans, the ongoing search for oil and gas, and new theoretical ideas, like plate tectonics and neocatastrophism. These also drove major changes in stratigraphy, ongoing since the latter twentieth century. Plate tectonics affected views of sedimentary basins, large-scale depositional processes, marine geology, and tectonics. Neocatastrophism grew out of theoretical (e.g., Hooykaas, 1963) and empirical (Ager, 1973, 1993; Alvarez et al., 1980; Bretz, 1923, 1925) challenges to uniformitarianism. However, the essential commitment to Lyellianism remains dominant in historical science (Kravitz, 2013; Miall, 2012; Reed, 2010, 2011;

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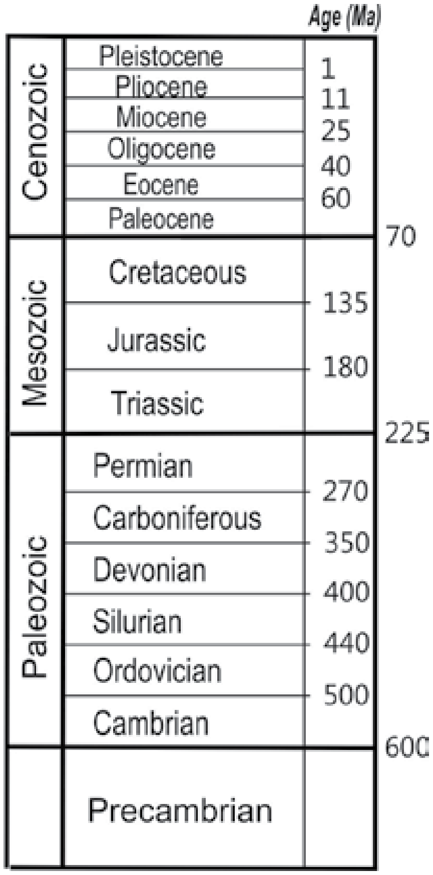


Figure 1. Geologic timescale from Holmes (1960).

Reed and Williams, 2012; Romano, 2015). Geologists also are beginning to examine some of their assumptions and to recognize the tension between inductive (using specific examples to reach general conclusions) and deductive (reasoning from general principles to specifics) approaches to stratigraphy (Cleland, 2013; Miall, 2004).

Stratigraphy has been profoundly affected. We suspect that many remain unaware of the extent, centered on an increasingly complex and refined geologic timescale compared to that of the mid-twentieth century (Figure 1). The International Commission on Stratigraphy (ICS) has taken the lead as the caretaker of the timescale (Gradstein et al., 2004a, 2012). Comparison of the timescale from 1960 to today (Figure 2) shows a dramatic increase in detail.

> Its supporting methods have also grown more complex, though the purpose remains the same: It is, in fact, fundamental to the understanding of the history of Earth that events be meticulously correlated in time. (Miall, 2004, p. 11)

Traditional methods (biostratigraphy and radiometric dating) have become more sophisticated. The ability to store, share, and analyze large databases has combined with statistical and mathematical models to extract more information from fossil assemblages. Technological innovations in sampling, laboratory methods, and analysis also have led to new and improved isotope methods (Gradstein et al., 2012). Second, new methods have been introduced and used with increasing confidence. Two "newcomers" are *magnetostratigraphy* and *cyclostratigraphy*, with stable isotope stratigraphy and sequence stratigraphy also becoming prominent. At present, the basic pillars of the timescale include: (1) biostratigraphy, (2) isotopic dating, (3) magnetostratigraphy, and (4) cyclostratigraphy (Figure 3).

Through all these changes, the goal of stratigraphy remains the same. It is to classify scattered rock formations by assigning them an age and then globally correlating the rocks by those ages. Historically, this has been done in a two-step process: (1) chronostratigraphy and (2) geochronology. *Chronostratigraphy* is the ordering of rocks into a relative sequence, and *geochronology* assigns them an absolute age (Ferrusquía-Villafranca et al., 2009). Combining the two methods yields the timescale shown in Figure 2. However, a new school of thought is attempting to subsume chronostratigraphy into geochronology:

> We consider that the practice of Chronostratigraphy today defines the time framework of Geochronology, because intervals of geological time are now being precisely defined within rock successions by GSSPs. *The effect of this is that Chronostratigraphy and Geochronology should become one and the same discipline*. (Gradstein et al., 2004b, p. 41, emphasis added)

This new approach restricts empirical uncertainty but at the cost of making the rock record a matter of definition rather than investigation. This is done by codifying the absolute ages that make up the timescale, using *Global Stratotype Section and Points* (GSSPs) for the Phanerozoic and *Global Standard Stratigraphic Ages* (GSSAs) for the Precambrian (Reed, 2008a; 2008b; 2008c; 2008d). In other words, once ages are determined for each stratigraphic stage, those ages are set for all equivalent strata. One reason this new strategy has gained traction among geologists is their belief that more sophisticated methods, like cyclostratigraphy, provide the high-resolution dating needed to make such a proposal feasible.

We will discuss other stratigraphic methods in subsequent series. Creationists need to understand each of them, their role in supporting the timescale, and their strengths and weaknesses. We will describe each method, trace its development, and offer critiques of the methods and their underlying assumptions.

Cyclostratigraphy and Astrochronology

"Cyclostratigraphy is the study of astronomically forced cycles in the sedimentary record" (Miall, 2012, p. 11). It assumes that features of sediments and sedimentary rocks, especially those manifested in any cyclical manner, can be dated by linking those cycles to those on an astronomical "clock." *Astrochronology* is the development of that absolute "clock" based on Milankovitch cycles derived from the orbital mechanics of our solar system (Hinnov and Hilgen, 2012). The resulting astronomical timescale is

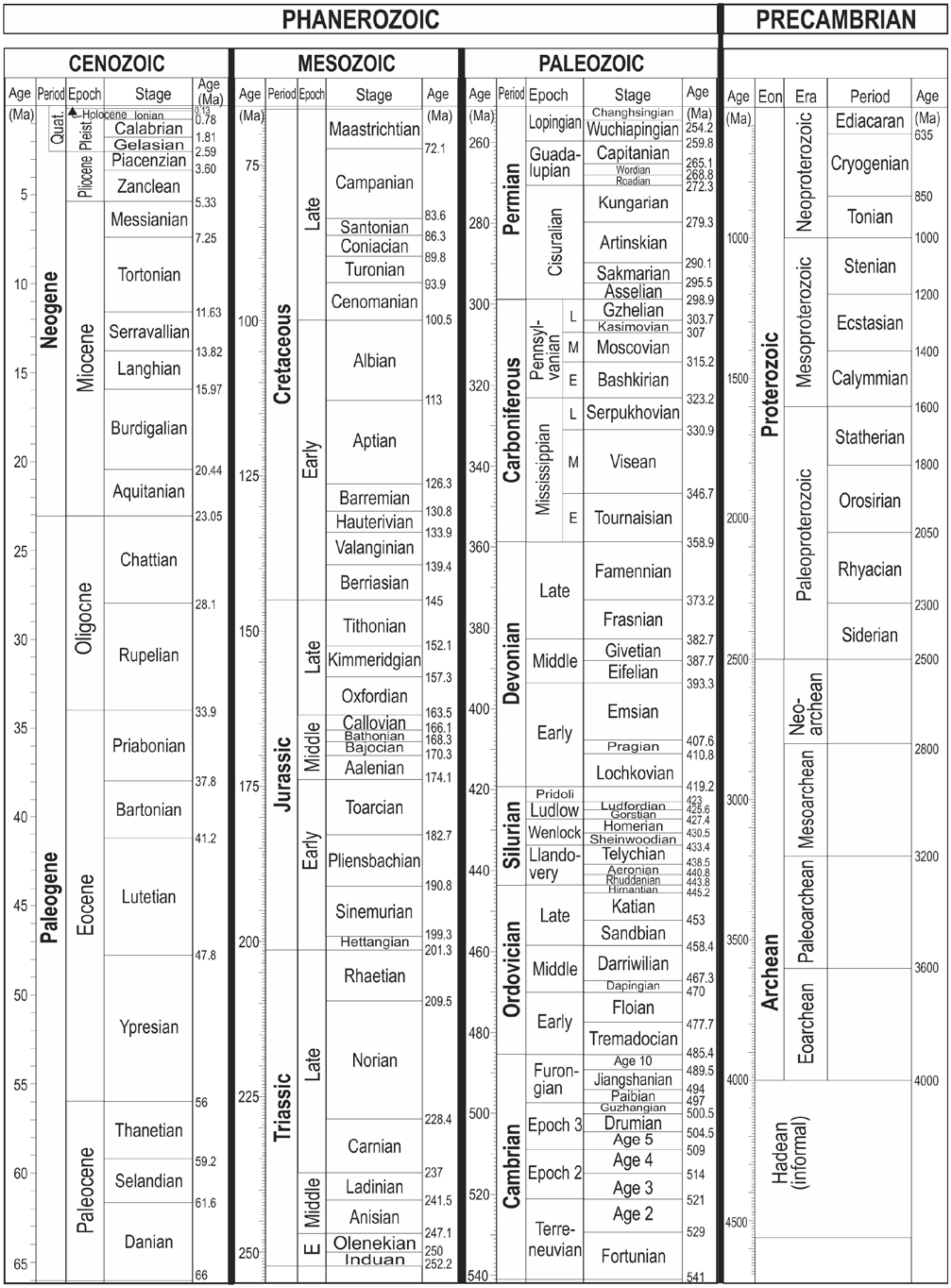


Figure 2. Geologic timescale based on International Commission on Stratigraphy's 2012 GTS. Traditionally, the combination of the relative position of the stages and their absolute age defined the timescale. Some, however, believe that since the absolute age defines the relative position, that the two are really one and the same.

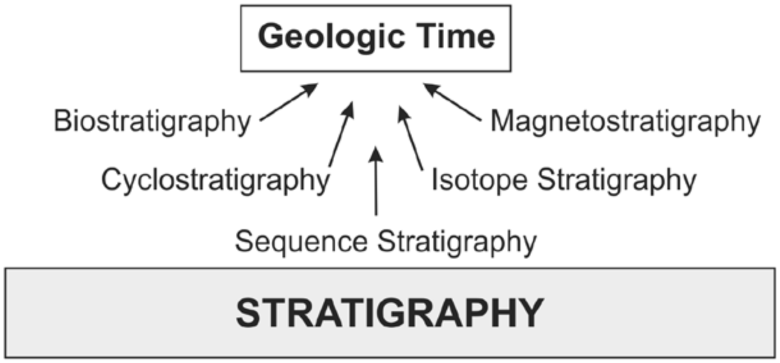


Figure 3. Geologic time rests on a variety of stratigraphic methods that are significantly more complex than the old biostratigraphy and radiometric dating.

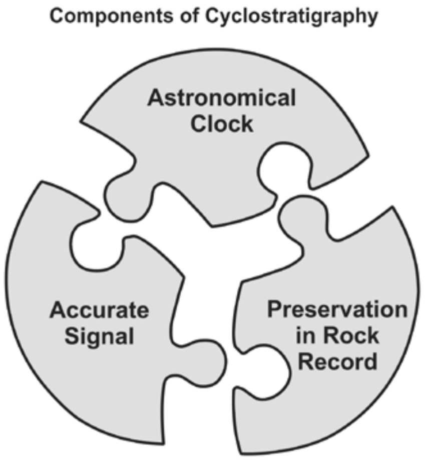


Figure 4. Cyclostratigraphy depends on the reality and accuracy of an astronomical clock, the accurate relay of the time signal to Earth via astronomically forced climate variation, and the preservation of these variations in sedimentary units that both capture this signal and are sufficiently sensitive to record its small changes in chemical, biogenic, and sedimentary fluctuations.

calibrated to sediments on Earth in a two-step manner: first through variations in sunlight, the *insolation signal*, which force climate change through time; and second, linking those climate changes to proxies in the rock record, such as the fractions of oxygen isotopes found in the sedimentary record. Because of the dependence on the extraterrestrial clock, the method has also been called "astronomical tuning" (Gradstein et al., 2004a). There are thus three critical components to cyclostratigraphy: (1) an astronomical clock, (2) the accurate transmission of its signal through sunlight fluctuations and climate variations, and (3) the preservation of that signal in the rock record (Figure 4). All three aspects must be understood to understand the overall method. But first we will demonstrate the importance of cyclostratigraphy to earth science.

Importance of Cyclostratigraphy

Cyclostratigraphy and its sister methods are driven by a need for increasing accuracy and precision in developing a chronology of Earth's past. This has led to the ongoing subdivision of the timescale into numerous stages of only a few million years in length; the old joke about dating methods yielding results that "give or take a few million years" is no laughing matter for the new timescale. The potential for severe cumulative error demands increasing accuracy and precision. This was one of the driving forces behind sequence stratigraphy and cyclostratigraphy, which claim error ranges in thousands, not millions, of years.

Currently, this presumed accuracy, enabled by the timing of various "Milankovitch cycles" (Gradstein et al., 2012) is calibrated to the timescale only through the Cenozoic with precision, but it continues to move back, making inroads into the Mesozoic and Paleozoic eras through "floating" timescales, or those that show a cyclic time signature for the section in question and can be linked to an absolute age on the timescale but are not yet linked to a continuous record of Milankovitch cycles covering all of time. A major goal of stratigraphers is to provide such linkage, allowing the correlation of the astronomical timescale with the sedimentary record as far back as they can take it (Gradstein et al., 2012).

Another important benefit of cyclostratigraphy is its support of the claim that the timescale is buttressed by multiple, overlapping, independent dating methods. Stung by criticisms of creationists, which focused on fossil succession and radiometric dating, geologists now believe that their new "clocks" add certainty to their chronology. Since cyclostratigraphy rests on the regularity of the motions of celestial bodies, it is perceived as being less vulnerable to criticism than other methods.

However, these two driving forces, increasing precision and an assumed support for other dating methods, are at odds with each other. If cyclostratigraphy is beneficial because it provides accurate dates within 10^4–10^5 years, and if radiometric dating and fossil dating cannot provide the same precision, then the benefit of having multiple, independent lines of evidence is limited. Since other geochronological methods cannot provide this precision, they cannot be calibrated to astronomical cycles within their tighter range of precision. For example, a radiometric age might only be accurate within 10^6 years. That is one to two orders of magnitude less precise than an astronomical cycle. Thus, the different methods cannot support the precision claimed in an overlapping fashion. At best, there can be agreement only within the range of dates provided by the *least* precise method.

Development of Cyclostratigraphy

The development of cyclostratigraphy and astrochronology is the subject of the next paper in this series, but a brief summary is appropriate here. The method dates back to the 1840s theory that glacial melting would affect sea level (Miall, 2012). Pioneers of the theory included Herschel (1830), Adhémar (1842), Lyell (1867), and Croll (1875). Geologists have always been interested in cycles in sedimentary rocks, and various researchers explored an astronomical connection (e.g., Bradley, 1929; Gilbert, 1895). This theory was boosted by the ability to quantify the cycles produced by orbital mechanics in the work of Milankovitch (1941). Using these cycles as a chronometer was first done for glacial sediments and later extended to older sedimentary rocks (e.g., Fischer, 1986). A variety of sedimentary proxies have been developed, allowing a linkage between the astronomical cycles and sedimentary layers. This has led to a new branch of stratigraphy.

> Over the past century, paleoclimatological research has led to wide acceptance that quasi-periodic oscillations in the Sun-Earth position have induced significant variations in the Earth's past climate. These orbitally forced variations influenced climate-sensitive sedimentation, and thereby came to be fossilized in the Earth's cyclic stratigraphic record. (Hinnov, 2004, p. 55)

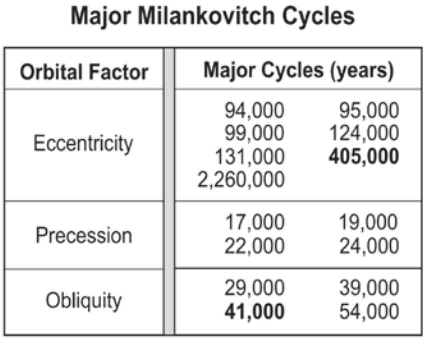
Basics of Cyclostratigraphy

Cyclostratigraphy rests on the idea that the amount of solar radiation reaching Earth at a given time is manifested in changes in preserved sedimentary rocks. Oscillations in orbital mechanics are thought to create regular cycles. Peaks and troughs in these cycles combine to create variations in the amount of solar heat reaching the lower atmosphere and ground. The Milankovitch theory combines three orbital parameters to generate a predicted curve of solar radiation and, by inference, cycles of climate change (cf. Oard, 1984).

Predicted cycles from astronomical models are then compared to sedimentary rocks (Hebert, 2014; Oard, 1997), especially those from deep-sea environments. Geologists use variations in oxygen and carbon isotopes, clay mineralogy, microfossil assemblages, sediment color, grain size, clay/dust abundance, microfossil abundance, and the percentage of silica, carbonate, and organic carbon in pelagic muds to calibrate sedimentary cycles to Milankovitch cycles.

In short, astronomical oscillation affects sunlight, sunlight affects climate, and climate is mirrored in sediments. It offers the advantages of potentially dating with greater precision and offering a new dating method that can support traditional biostratigraphy and radiometric dating. As recently as 2004, this process was still limited to relatively recent sediments (Gradstein, 2004, p. 4; Hinnov, 2004), but at present, progress has been extended back (Hinnov and Hilgen, 2012), and geologists seem determined to push the method deeper into geologic time. It is now claimed that these astronomical models are *accurately* tied to geochronology as far back as 40 Ma, and *reasonably* so back to 60 Ma (Hinnov and Hilgen, 2012). Each of the major variables results in variations with principal periods in the tens to hundreds of thousands of years (Figure 5). One of the most important for older strata is the 405-kyr eccentricity cycle:

> The 405 kyr eccentricity cycle has remained relatively stable over at least the past 250 million years. … This high-amplitude cycle is the consequence of gravitational interactions between Jupiter and Venus. … The large mass of Jupiter is responsible for the stability of the 405-kyr cycle, which has an estimated uncertainty of ~500 kyr at 250 Ma. Thus, this cycle can be used as a basic calibration period for cyclostratigraphy … The long-term goal of astrochronology is to assign ("tune") cyclostratigraphy to the appropriate 405-kyr bins. (Hinnov and Hilgen, 2012, p. 67)



Major Milankovitch Cycles

Orbital Factor	Major Cycles (years)	
Eccentricity	94,000	95,000
	99,000	124,000
	131,000	**405,000**
	2,260,000	
Precession	17,000	19,000
	22,000	24,000
Obliquity	29,000	39,000
	41,000	54,000

Figure 5. Major cycles derived from orbital mechanics. From Hinnov and Hilgen (2012).

Inside the Milankovitch Mechanism

The astronomical theory, or "Milankovitch mechanism," is based on changes in solar radiation due to the changing position of Earth relative to the sun, caused by cyclical variations in Earth's orbital geometry. These are assumed to be uniform through time, and complex astronomical models have been assembled to account for a number of variables (e.g. Laskar et al., 2004, 2011), although minor factors render the models inaccurate over longer periods of time greater than about 65 million years (Hinnov and Hilgen, 2012). The primary cycles are tied to three major variables: (1) changes in the *eccentricity* of Earth's orbit about the sun, (2) the *precession* of the equinoxes, and (3) changes in *obliquity*, or the tilt of Earth's axis (Figure 6; cf. Hebert, 2014; Milankovitch, 1941; Oard, 1984, 2005).

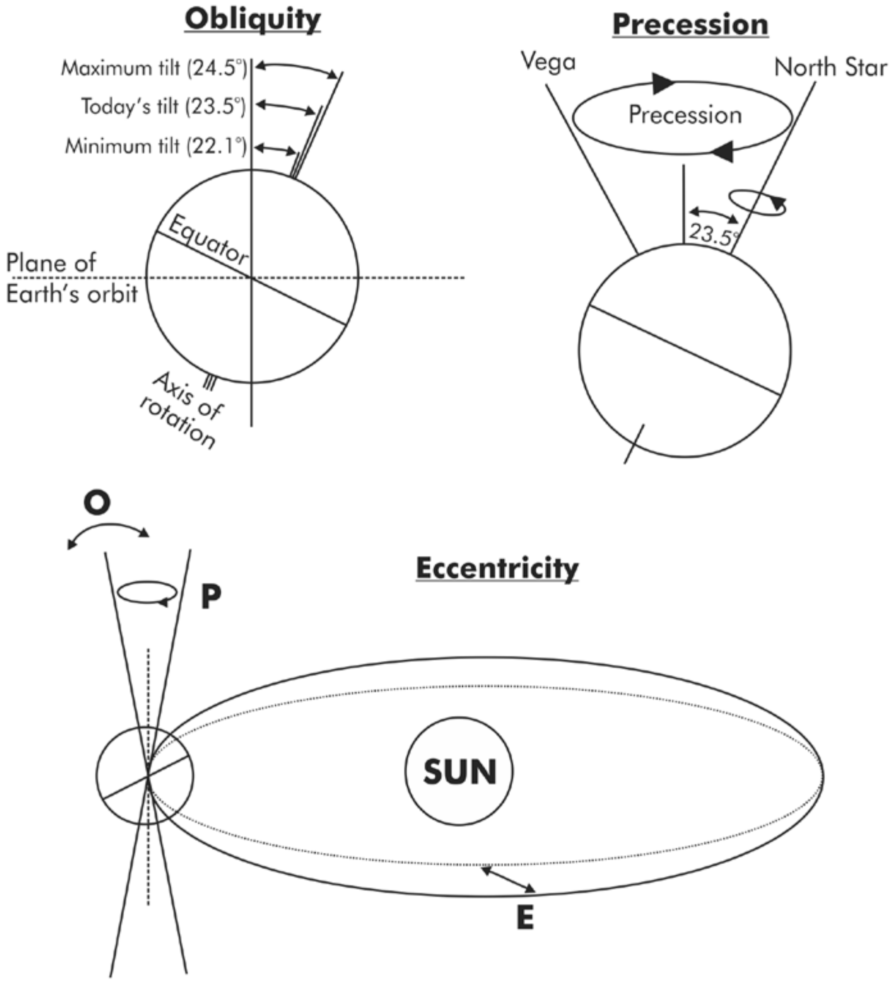


Figure 6. The Milankovitch theory claims to explain changes in the insolation signal by three orbital parameters: *Obliquity* (O), the tilt of Earth's axis of spin with respect to the ecliptic, with a dominant cycle of 41,000 years, with minor cycles of 29,000, 39,000, and 54,000 years; *Precession* (P), the wobble in Earth's spin that varies in principal cycles of 17,000, 19,000, 22,000, and 24,000 years; and *Eccentricity* (E), the variation in the elliptical shape of Earth's orbit, with principal periods of 95,000, 99,000, 124,000, 131,000, 405,000, and 2,260,000 years. Computer modeling relies on the 405,000-year sequence as a primary correlation marker for cyclostratigraphy. From Reed (2013).

Eccentricity Variation

Kepler showed that planetary orbits were elliptical. Eccentricity is a measure of the flatness of the ellipse or its deviation from a circle. An eccentricity of zero is a perfect circle, while an eccentricity of one is an ellipse so flat as to form a line. Presently, Earth's eccentricity is 0.017 and is caused by the gravitational pull of other planets. Earth's closest approach to the Sun is called the *perihelion* and the farthest distance is called the *aphelion*. Earth's perihelion occurs on January 3 at a distance of 91.5 million miles, while its aphelion is on July 4 (Figure 7) at 94.5 million miles, a difference of 3 million miles.

Based on an orbital mechanical extrapolation into the past, the eccentricity of Earth's orbit has been worked out for many millions of years. The eccentricity varies from near zero to a maximum of about 0.07. Figure 8 shows the change in the eccentricity for the past 2 million years (Vernekar, 1972). There are two major periods of oscillation, one at about 99,000 years and the second at approximately 405,000 years.

Variation of the Precession of the Equinoxes

The precession of the equinoxes is the rotation of the cardinal points—the equinoxes and solstices—around Earth's orbit. It is caused by two forces. The first causes the cardinal points to rotate clockwise along Earth's orbit due to the differential gravitational attraction by the sun and moon on Earth's poles and equatorial bulge. This force assumes a stationary elliptical orbit, but the orbit itself, the second force, actually rotates around the earth counterclockwise, but at a much slower rate, and is caused partly by the changing gravitational response of the other planets. Precession is seen more clearly using the reference point of the fixed stars. Over a long period of time, the axis of the earth's rotation wobbles like a spinning top (Figure 9).

One precessional cycle is defined as the time needed for the vernal or spring equinox to make one complete orbital rotation. This takes approximately 22,000 years. Currently, the vernal equinox is about March 20 (Figure 7), and it would take 11,000 years for this equinox to rotate through half of its orbit, through aphelion to the point where the autumnal equinox is now located. Then it would continue through perihelion to its current location in another 11,000 years.

The precession of the equinoxes depends on the eccentricity of the orbit. The eccentricity modulates the precession effect because it is the shape

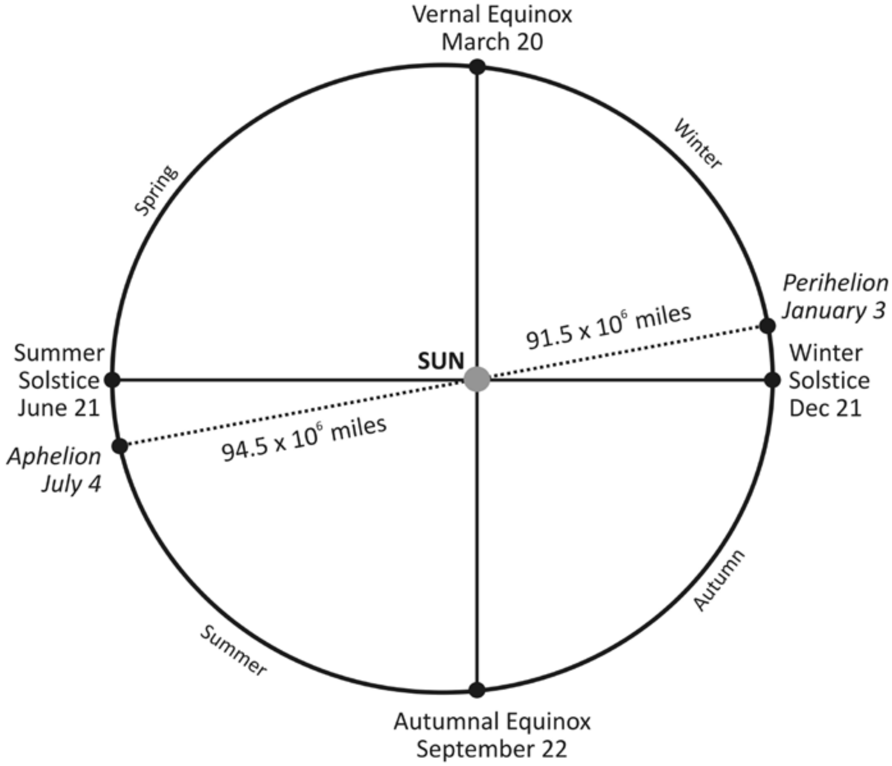


Figure 7. The current geometry of the earth's orbit around the sun. Modified from Imbrie and Imbrie (1979).

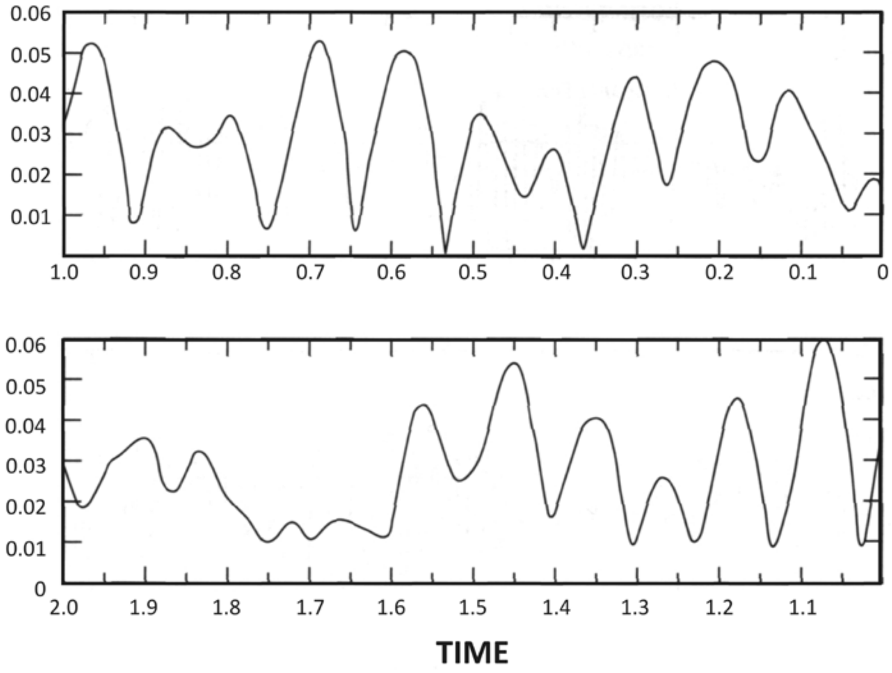


Figure 8. Variations in Earth's eccentricity for the past two million years. Modified from Vernekar (1972).

of the ellipse that determines the precessional change in solar radiation (Figure 10). For instance, if eccentricity were zero (a perfect circle), there would be no change in solar radiation from the precession of the equinoxes. As can be seen in figures 8 and 10, the period of low eccentricity around 1.7 million years ago had a slight precession change. On the other hand, when the eccentricity is high, around 0.6 about 1.1 million years ago (Figure 10), the precessional oscillations would have been quite large.

Obliquity (Tilt Cycle)

The third Milankovitch cycle is obliquity, or the tilt cycle. The current tilt of Earth's axis in relation to its plane of the *ecliptic* (the plane formed by the rotation of the earth around the sun) is 23.5°. Because of the gravitational pull of the other planets, the tilt wobbles a little from an angle of 22.1°to 24.5° with a major period of 41,000 years (Figure 11).

How Effective Is the Astronomical Clock?

However great the emphasis on these three orbital factors, the reality is that they have a small effect on the insolation signal (Elkibbi and Rial, 2001; Wunsch, 2004). Richard Kerr (2013, p. 599) states in *Science*: "For more than 30 years, climate researchers have been trying to figure out how slight changes in Earth's orbit could drive the major climate events of the last million years: the great ice ages." The question is whether or not the effect is sufficient to act as the primary driver of climate to the extent that the change would be preserved in sedimentary rocks. Furthermore, the changes in insolation are not constant over each hemisphere for a full year (Imbrie and Imbrie, 1979; Vernekar, 1972). The Milankovitch mechanism only changes the *seasonal and latitudinal distribution* of solar radiation. The precessional cycle mainly affects the *distribution* of the seasonal solar radiation and has the strongest effect in lower

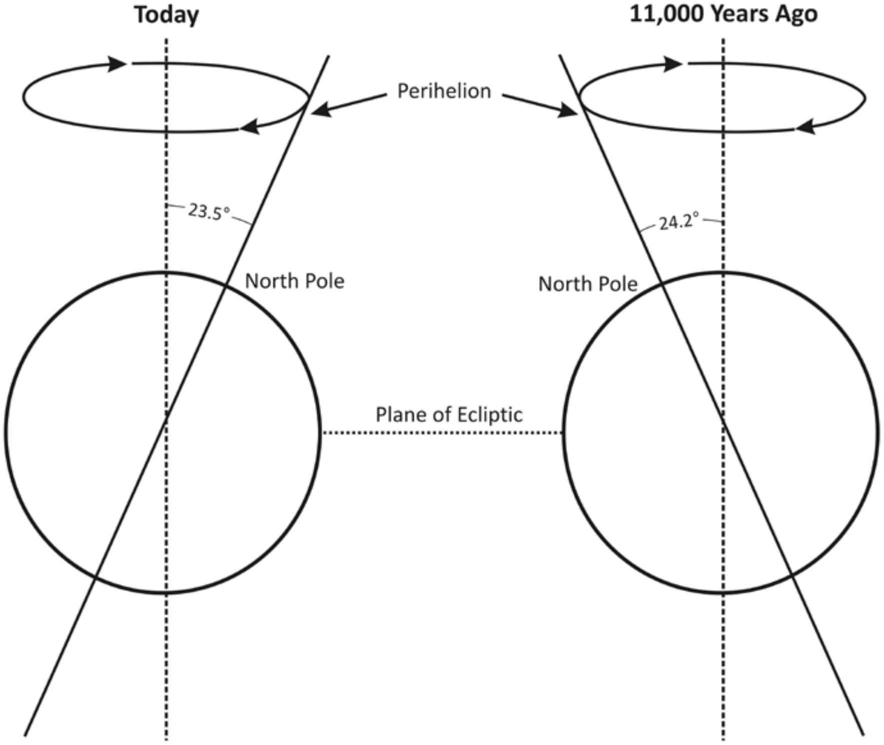


Figure 9. The change in Earth's axis of rotation, as seen from fixed stars, today and 11,000 years ago. Also shown is the change in tilt of Earth's axis during that time. Modified from Fodor (1982).

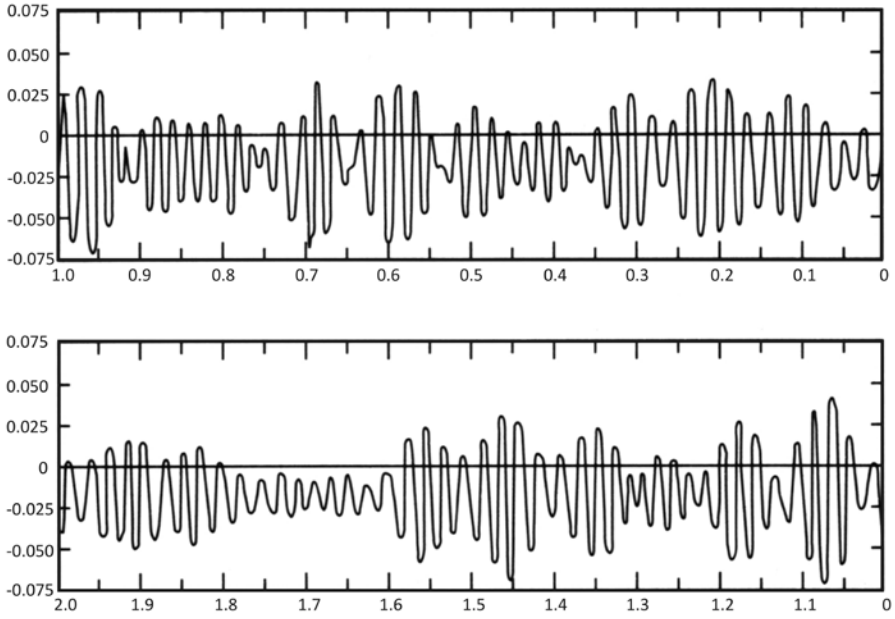


Figure 10. Variation in precession of the equinoxes over the past two million years, modulated by the change in the eccentricity of Earth's orbit. Time units (X axis) in hundreds of thousands of years. Modified from Vernekar (1972).

latitudes. For instance, when the warm half of the year shows a solar radiation minimum in the Northern Hemisphere, the winter compensates by an above normal change in solar radiation (Imbrie and Imbrie, 1979; Vernekar, 1972). Furthermore, the precessional cycle is out of phase between the hemispheres. While the Northern Hemisphere receives above-normal sunlight during summer, the Southern Hemisphere receives less because it is winter, and the tilt cycle causes insolation variations by latitude. When insolation is below average in high latitudes, it is above average in lower latitudes, but without any net change for the hemisphere as a whole.

Preservation in Sedimentary Record

Geologists initially attempted to apply the idea of cyclical climate forcing on glacial advances, varves, and cyclothems. The breakthrough for cyclostratigraphy came during the various ocean drilling programs that began in 1975. Currently, the program has accumulated well, sampling, and seismic data for more than 350 locations, and has correlated cycles in cores from these wells to the astrochronological timescale (Hinnov and Hilgen, 2012). Obviously, this exercise requires proxies for climate change in sedimentary rocks. Over recent decades, a number of proxies have been used (Figure 12).

Summary

Cyclostratigraphy/astrochronology has become a major method in stratigraphy, responsible for finely tuned (10^4–10^5 years) geochronologic ages that have contributed to the increasing complexity and precision of the geologic timescale (Figure 2). At present, "firm" dates are available only back through the Cenozoic, but the trend clearly indicates that this will be pushed deeper in time within the next decades.

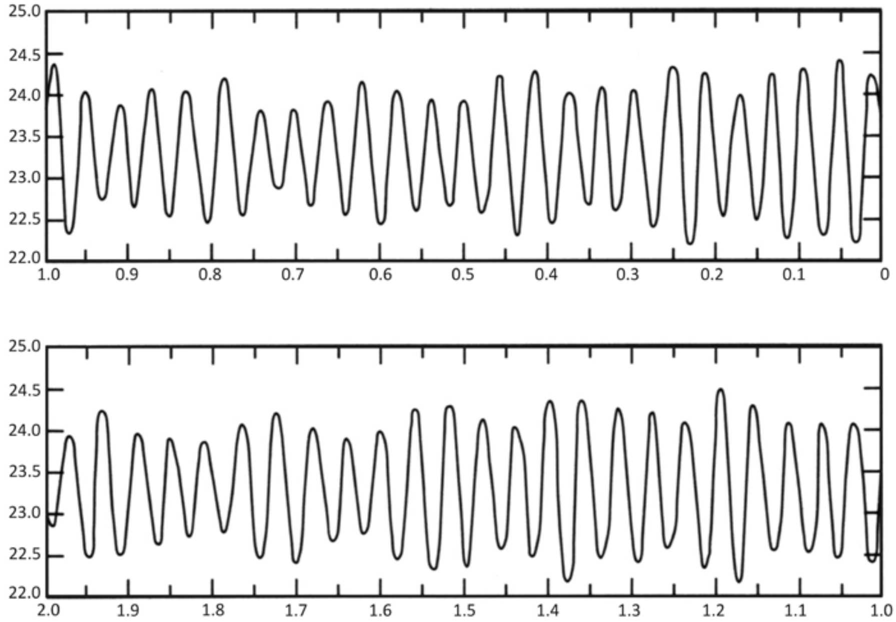
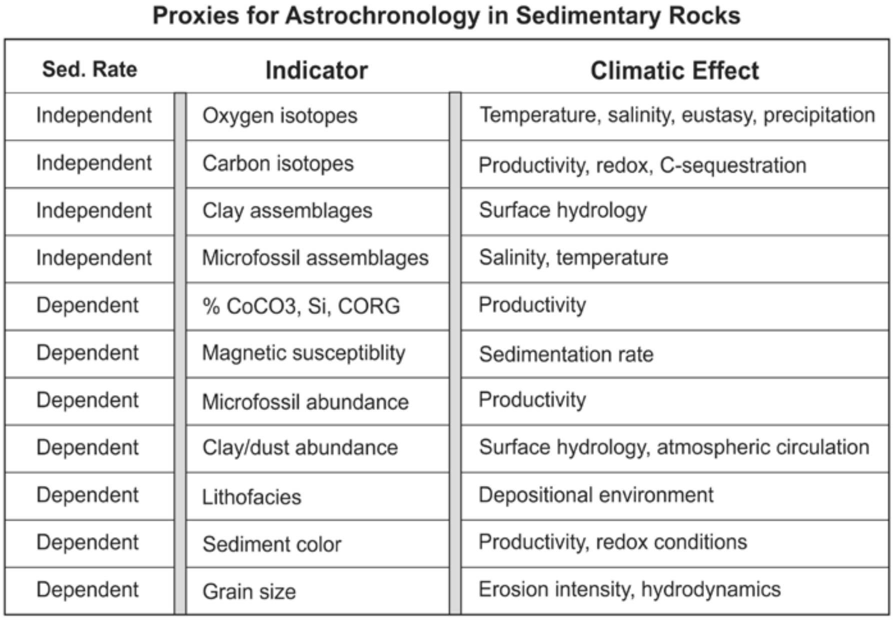


Figure 11. Variation in tilt of Earth's axis for past two million years. Time units (X axis) in hundreds of thousands of years. Modified from Vernekar (1972).



Proxies for Astrochronology in Sedimentary Rocks

Sed. Rate	Indicator	Climatic Effect
Independent	Oxygen isotopes	Temperature, salinity, eustasy, precipitation
Independent	Carbon isotopes	Productivity, redox, C-sequestration
Independent	Clay assemblages	Surface hydrology
Independent	Microfossil assemblages	Salinity, temperature
Dependent	% CoCO3, Si, CORG	Productivity
Dependent	Magnetic susceptiblity	Sedimentation rate
Dependent	Microfossil abundance	Productivity
Dependent	Clay/dust abundance	Surface hydrology, atmospheric circulation
Dependent	Lithofacies	Depositional environment
Dependent	Sediment color	Productivity, redox conditions
Dependent	Grain size	Erosion intensity, hydrodynamics

Figure 12. A number of climate proxies have been used to calibrate sedimentary sequences in an attempt to demonstrate astronomical forcing of deposition. From Hinnov and Hilgen (2012).

Cyclostratigraphy depends on the theory that cycles generated by orbital mechanics, especially with regard to eccentricity, precession, and obliquity, force climatic changes on Earth that are sufficiently powerful to be imprinted in sedimentary rocks through a variety of climatic proxies.

There can be no doubt that this method deserves more attention from creationists who wish to understand current advances in stratigraphy and the geologic timescale. In part II of this series, we will trace the historical development of cyclostratigraphy and astrochronology. In part III, we will critique the astronomical timescale, and part IV will conclude with a critique of cyclostratigraphy and its geological applications.

References

CRSQ: *Creation Research Society Quarterly*

Adhémar, J. 1842. *Les Révolutions de la Mer, Déluges Périodiques*. Carilian Gourey et V. Dalmort, Paris.

Ager, D.V. 1973. *The Nature of the Stratigraphical Record*. Wiley, New York, NY.

Ager, D.V. 1993. *The New Catastrophism*. Cambridge University Press, New York, NY.

Alvarez, L.W., W. Alvarez, F. Asaro, and H.V. Michel. 1980. Extraterrestrial cause for the Cretaceous-Tertiary extinction. *Science* 208:1095–1108.

Bradley, W.H. 1929. *The Varves and Climate of the Green River Epoch*. Professional Paper 158-E, 87–110. U.S. Geological Survey, Washington, DC.

Bretz, J.H. 1923. The channeled scabland of the Columbia Plateau. *Journal of Geology* 31:617–649.

Bretz, J.H. 1925. The Spokane flood beyond the channeled scablands. *Journal of Geology* 33:97–115, 236–259.

Cleland, C.E. 2013. Common cause explanation and the search for the "smoking gun." In Baker, V.R. (editor), *Rethinking the Fabric of Geology*, pp. 1–10. Geological Society of America Special Paper 502, Boulder, CO.

Croll, J. 1875. *Climate and Time in their Geological Relations*. Appleton, New York, NY.

Elkibbi, M., and J.A. Rial. 2001. An outsider's review of the astronomical theory of the climate; is the eccentricity-driven insolation the main driver of the ice ages? *Earth-Science Reviews* 56:161–177.

Ferrusquía-Villafranca, I., R.M Easton, and D.E. Owen. 2009. Do GSSPs render dual time-rock/time classification and nomenclature redundant? *Stratigraphy* 6(2): 135–169.

Fischer, A.G. 1986. Climatic rhythms recorded in strata. *Annual Review of Earth and Planetary Sciences* 14:351–376.

Fodor, R.V. 1982. Frozen earth: explaining the ice ages. *Weatherwise* 35(3): 109–114.

Gentry, R.V. 1966. Cosmological implications of extinct radioactivity from pleochroic halos. *CRSQ* 3:17–20.

Gilbert, G.K. 1895. Sedimentary measurement of geologic time. *Journal of Geology* 3:121–127.

Gish, D. 1972. *Evolution: The Fossils Say No!* Master Books, San Diego, CA.

Gradstein, F.M. 2004. “Introduction.” In Gradstein, F.M., J.G. Ogg, and A.G. Smith (editors), *A Geologic Time Scale 2004*. Cambridge University Press, Cambridge, UK.

Gradstein, F.M., J.G. Ogg, and A.G. Smith (editors). 2004a. *A Geologic Time Scale 2004*. Cambridge University Press, Cambridge, UK.

Gradstein, F.M., J.G. Ogg, and A.G. Smith. 2004b. Chronostratigraphy: linking time and rock. In Gradstein, F.M., J.G. Ogg, and A.G. Smith (editors), *A Geologic Time Scale 2004*, pp. 20–47. Cambridge University Press, Cambridge, UK.

Gradstein, F.M., J.G. Ogg, M.D. Schmitz, and G.M. Ogg (editors). 2012. *The Geologic Time Scale 2012*. Elsevier, Amsterdam, Netherlands.

Hebert, J. 2014. Circular reasoning in the dating of deep seafloor sediments and ice cores: the orbital tuning method. *Answers Research Journal* 7:297–309.

Herschel, J.F.W. 1830. On the geological causes which may influence geological phenomena. *Geological Transactions* 3:293–299.

Hinnov, L.A. 2004. Earth’s orbital parameters and cycle stratigraphy. In Gradstein, F.M., J.G. Ogg, and A.G. Smith (editors), *A Geologic Time Scale 2004*, pp. 55–62. Cambridge University Press, Cambridge, UK.

Hinnov, L.A., and F.J. Hilgen. 2012. Cyclostratigraphy and astrochronology. In Gradstein, F.M., J.G. Ogg, M.D. Schmitz, and G.M. Ogg (editors), *The Geologic Time Scale 2012*. Elsevier, Amsterdam, Netherlands.

Holmes, A. 1960. A revised geologic timescale. *Transactions of the Edinburgh Geological Society* 17:183–216.

Hooykaas, R. 1963. *The Principle of Uniformity in Geology, Biology, and Theology*, second impression. E.J. Brill, London, UK.

Imbrie, J., and K.P. Imbrie. 1979. *Ice Ages: Solving the Mystery*. Enslow Publishers, Short Hills, NJ.

Kerr, R.A. 2013. How to make a great ice age, again and again and again. *Science* 341:599.

Kravitz, Gadi. 2013. The thermodynamics time arrow and the logical function of the uniformity principle in geohistorical explanation. In Baker, V.R. (editor), *Rethinking the Fabric of Geology*, pp. 19–40. Geological Society of America Special Paper 502, Boulder, CO.

Laskar, J., P. Robutel, J. Joutel, M. Gastineau, A.C.M. Correia, and B. Levrard. 2004. A numerical solution for the insolation quantities of the Earth. *Astronomy and Astrophysics* 428:261–285.

Laskar, J., A. Fienga, M. Gastineau, and H. Manche. 2011. La2010: a new orbital solution for the long-term motion of the Earth. *Astronomy & Astrophysics* 532(A89): 1–15.

Lyell, C. 1867. *Principles of Geology*, tenth edition. John Murray, London, England.

Miall, A.D. 2004. Empiricism and model building in stratigraphy: the historical roots of present-day practices. *Stratigraphy* 1(1): 3–25.

Miall, A.D. 2012. Sophisticated stratigraphy. Preprint of a contribution to the volume celebrating the 125th anniversary of the Geological Society of America.

Milankovitch, M. 1941. *Kanon der Erdbestrahlung und seine Anwendung auf das Eiszeitenproblem*. Royal Serbian Academy, Section of Mathematical and Natural Sciences, Belgrade, Yugoslavia. Reissued in English in 1998 as *Canon of Insolation and the Ice-Age Problem*. Serbian Academy of Sciences and Arts, Section of Mathematical and Natural Sciences, Belgrade, Yugoslavia.

Mortenson, T. 2004. *The Great Turning Point: The Church’s Catastrophic Mistake on Geology before Darwin*. Master Books, Green Forest, AR.

Oard, M.J., 1984. Ice ages: the mystery solved? Part I: the inadequacy of a uniformitarian ice age. *CRSQ* 21:66–76.

Oard, M.J. 1997. Are pre-Pleistocene rhythmites caused by the Milankovitch mechanism? *Journal of Creation (Creation Ex Nihilo Technical Journal)* 11(2): 126–128.

Oard, M.J. 2005. *The Frozen Record: Examining the Ice Core History of the Greenland and Antarctic Ice Sheets*. Institute for Creation Research, Dallas, TX.

Reed, J.K. 2008a. Toppling the timescale, part I: evaluating the terrain. *CRSQ* 44:174–178.

Reed, J.K. 2008b. Toppling the timescale, part II: unearthing the cornerstone. *CRSQ* 44:256–263.

Reed, J.K. 2008c. Toppling the timescale, part III: madness in the methods. *CRSQ* 45:6–17.

Reed, J.K. 2008d. Toppling the timescale, part IV: assaying the golden (FeS_2) spikes. *CRSQ* 45:81–89.

Reed, J.K. 2010. Untangling uniformitarianism, level I: a quest for clarity. *Answers Research Journal* 3:37–59.

Reed, J.K. 2011. Untangling uniformitarianism, level II: actualism in crisis. *Answers Research Journal* 4:203–215.

Reed, J.K. 2013. *Rocks aren’t Clocks*. Creation Book Publishers, Powder Springs, GA.

Reed, J.K., and E.L. Williams. 2012. Battlegrounds of natural history, part II: actualism. *CRSQ* 49:135–152.

Romano, M. 2015. Reviewing the term uniformitarianism in modern Earth sciences. *Earth-Science Reviews* 148:65–76.

Torrens, H.S. 2002. Some personal thoughts on stratigraphic precision in the twentieth century. In Oldroyd, D.R. (editor), *The Earth Inside and Out: Some Major Contributions to Geology in the Twentieth Century*, pp. 251–272. Special Publication 192, Geological Society, London, UK.

Vernekar. A.D. 1972. Long-period global variations of incoming solar radiation. *Meteorological Monograph* 12(34): 1–21 and tables.

Whitelaw, R.L. 1968. Radiocarbon confirms biblical creation (and so does Potassium-Argon). *CRSQ* 5:78–83.

Whitelaw, R.L. 1970. Time, life, and history in the light of 15,000 radiocarbon dates. *CRSQ* 7:56–71.

Woodmorappe, J. 1979. Radiometric geochronology reappraised. *CRSQ* 16:102–129.

Wunsch, C. 2004. Quantitative estimates of the Milankovitch-forced contribution to observed Quaternary climate change. *Quaternary Science Reviews* 23:1001–1012.

iDINO

Investigation of Dinosaur Intact Natural Osteo-tissue

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QUARTERLY

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THE iDINO PROJECT SPECIAL REPORT

- ORIGINAL BIOMATERIALS IN FOSSILS
- SOFT BONE MATERIAL FROM A BROW HORN OF A TRICERATOPS
- DINOSAUR TISSUE OR BACTERIAL BIOFILMS?
- DINOSAUR PEPTIDE PRESERVATION AND DEGRADATION
- HELL CREEK FORMATION: LAST GASP OF THE PRE-FLOOD DINOSAURS
- RADIOCARBON IN DINOSAUR AND OTHER FOSSILS

The spring 2015 issue of the *Creation Research Society Quarterly* features a special report of the iDINO project. Included in this report is a historical perspective of soft-tissue discoveries, an examination of the tissue found in a *Triceratops* horn, and a rebuttal of claims that the tissue is merely microbial contamination. In addition, the special report provides a detailed critique of the models offered by evolutionists to explain how this tissue has survived for millions of years. Also, provided is a discussion of how the Genesis Flood could account for the distribution of dinosaur fossils in North America, and an analysis of the significance of Carbon-14 still present in dinosaur fossils.

This issue of the *Quarterly* is a "must-read" for anyone interested in the topic of soft-tissue. Copies can still be obtained from the CRS Bookstore ($5 for members and $12 for nonmembers). Call us at 877-CRS-Book.

Creation Research Society Quarterly 2015. 52:106–135.

The Little Ice Age in the North Atlantic Region

Part VIII: Geologic Observations

Peter Klevberg, Michael J. Oard*

Abstract

Earlier papers in this series addressed the climatology and historic observations of the Medieval Warm Period and Little Ice Age and how the data obtained from the Little Ice Age should constrain our study of climate change and our speculations regarding previous glaciations. In this final paper of the series, geologic observations resulting from the Little Ice Age are presented. As climatologic observations from recent centuries should constrain paleoclimatology, so also should geologic observations from Little Ice Age deposits constrain our interpretation of apparently glacial deposits elsewhere.

Extent of Glaciation

In most places where continental glaciation is inferred to have taken place, the Little Ice Age was orders of magnitude less in its effects. In our study area (Figure 1), this is also true, but much less so than in many parts of the world. In Iceland, especially, the Little Ice Age produced observed impacts to landforms on a scale much closer to the effects from the inferred Great Ice Age. In general, the extent of glaciers in Iceland during the Little Ice Age duplicated the maximum previous extent based on locations of terminal moraines (Grove, 1988; McKinzey et al., 2005), though it is widely speculated that at least once in its history, Iceland was nearly covered with ice, which extended off the coast (Símonarson, 1980). In some cases, Little Ice Age advances overran these features (Evans and Twigg, 2002). In other cases, the Little Ice Age maximum extent fell short of terminal moraines (Grove, 1988; Haberle, 1991; but note disputed dates, e.g. Ives, 2007). Data from Norway and Greenland (see Klevberg and Oard, 2012b; 2014a) are less conclusive than the Icelandic data but generally in close agreement. In some other parts of the world (e.g., northern part of Canadian Rockies, Cascades, Himalayas), Little Ice Age advances apparently fell short of previous glacier terminal positions; these are generally continental environments, not maritime. Maritime climates would more adequately simulate the likely climatic conditions in the early postdiluvian period when warm oceans would have produced abundant moisture (Oard, 1990).

Applicability of Little Ice Age Observations

As the extent of Little Ice Age glaciation in parts of the study area was similar to previous (Great Ice Age) glaciation, geologic work can in general be inferred to have been similar in these locations, and we have paid particular attention to Iceland. Higher rates of work may have

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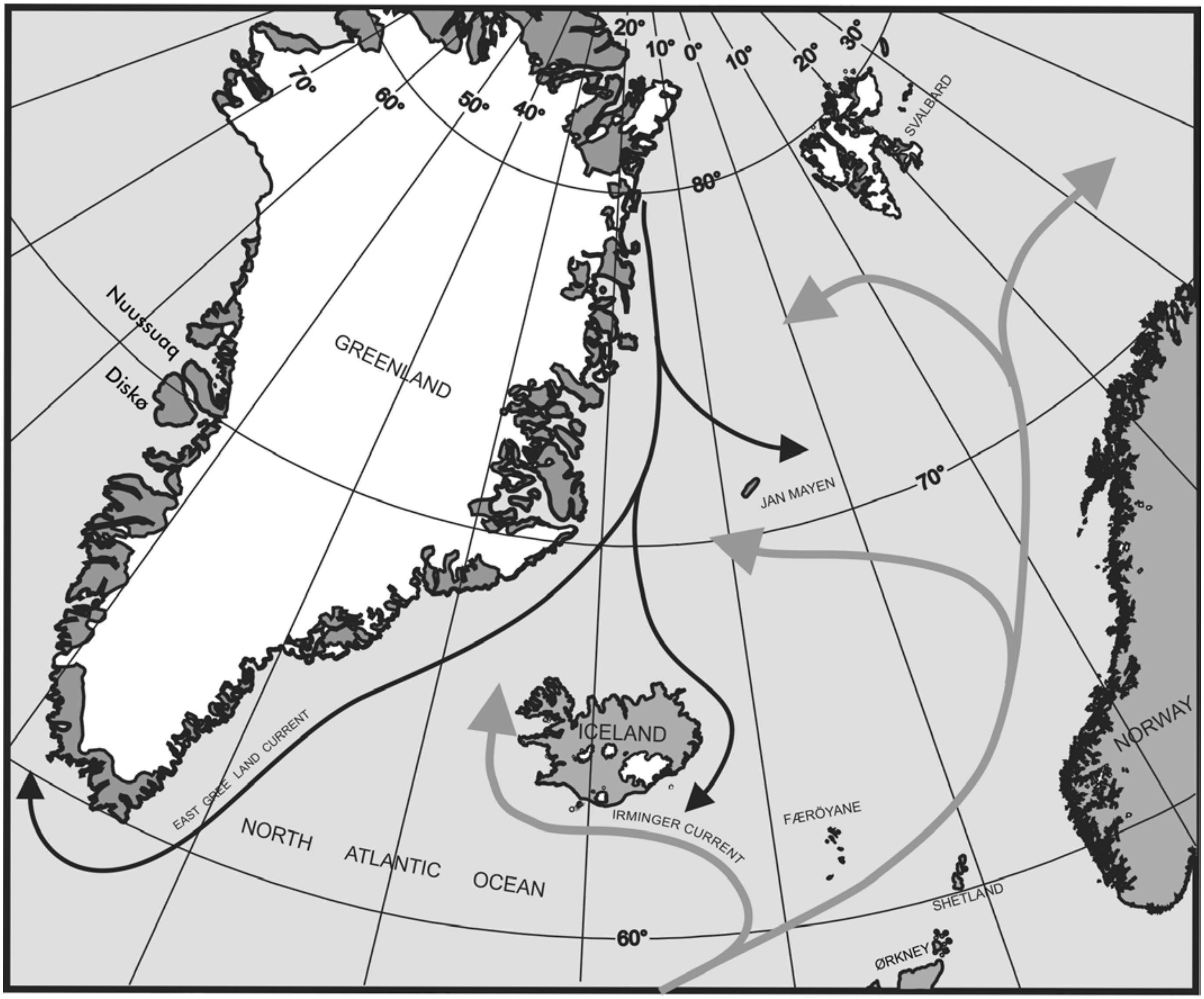

Figure 1. Map of study area.

resulted from higher rates of accumulation and transport, as well as more rapid melting, but the types of deposits and landforms created tend to be similar. For those unfamiliar with glacial landforms, a detour to the glossary and Appendix A may be in order. The aerial photographs in Appendix A are from southeastern Iceland and show many features that are documented to have formed during the Little Ice Age.

Geologic work can be conveniently categorized as erosional and depositional, though specific processes often erode and then deposit sediments. Effects can also be classified as deposits and landforms. Since glacial advances are prone to destroy previous landforms, many of the data available in glacial geology are derived from extant processes observed during the recession of glaciers that commenced at the end of the Little Ice Age.

The first paper in this series (Klevberg and Oard, 2011a) summarized paleoclimatic methods and the superiority of good historical records when these are available. While dates vary both by defining criteria and region (Klevberg and Oard, 2011b), the Little Ice Age in the study area lasted from approximately AD 1350 to 1890. All dates in this paper are therefore AD.

Glacial Erosion

Erosion consists of weathering and transport. Glacial weathering is largely physical, and glaciers are very effective

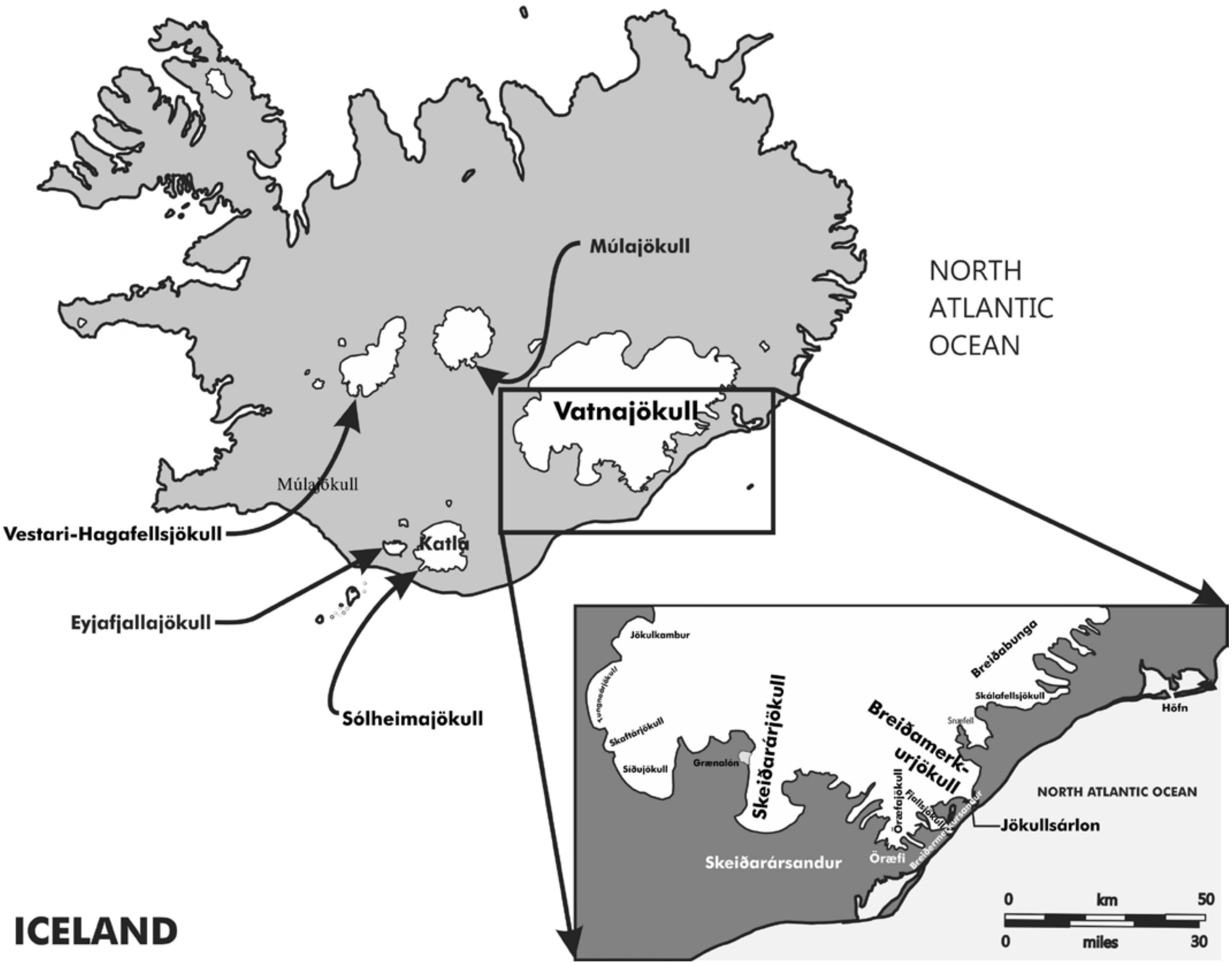

Figure 2. Map of Iceland showing important locations mentioned in text.

at developing high stresses to scratch and pluck bedrock.

Rates of Weathering and Transport

"There is relatively little information on Holocene chemical weathering rates in periglacial environments despite their implications for weathering-based dating and for the assumptions of cosmogenic dating" (Owen et al., 2007, p. 829). Such dating methods have produced anomalous results in areas of post-Little Ice Age recession (Hughes et al., 2012). What has been interpreted as chemical weathering due to age of exposure may in many cases be physical weathering resulting from recycling of sediments, with the most distal sediments being the most weathered as a result. This appears to have been confirmed for Bødalsbreen in Norway (Burki et al., 2010). Estimates of removal of gneiss bedrock at Fåbergstølsbreen in Norway for areas inferred to be glaciated during the Great Ice Age and adjacent areas known to have been glaciated during the Little Ice Age indicate glacial erosion averaged 158 mm/ka (and as much as 350 mm/ka), two orders of magnitude greater than the baseline chemical weathering rate (Owen et al., 2007). This is a significant rate of erosion for hard bedrock. Estimated contemporary erosion for Bødalsbreen, where both unconsolidated and consolidated materials have been eroded, was 800 mm/ka (0.8 mm per year), dropping to 700 mm/ka since the Little Ice Age (Burki et al., 2010). Evans and Twigg (2002, citing Björnsson, Boulton and

Figure 3. Vatnajökull, the world's largest ice cap (though a distant third behind the ice sheets of Antarctica and Greenland). It has been an area of intense study on the effects of the Little Ice Age.

others) estimate the minimum Little Ice Age erosion rate in the vicinity of Jökullsárlón in Iceland as 37 cm per year; the average rate for the period 1100 to 1900 was approximately 18 cm per year, with the estimated rate during the period of glacier advance 1765–1794, an impressive 4.9 m per year!

Mountain Glaciers

Studies of temperate North American cirque glaciers indicate headwall erosion proceeds most rapidly in bergschrunds. Freeze-thaw wedging is a known physical weathering mechanism, while fracture from dry thermal contraction is far less effective. "Several pioneering studies, however, have demonstrated that rock fracture by ice segregation (i.e., the fracture of intact rock by ice lenses that grow by drawing water from their surroundings during periods of sustained subfreezing temperatures) is a more effective weathering process than freeze-thaw" (Sanders et al., 2012, p. 779). This accelerated weathering in bergschrunds can explain the headward erosion of glaciated valleys and the resulting ridge asymmetry where climate is marginal for glaciation (Naylor and Gabet, 2007). "Cooling shifts the most favorable environment for frost damage to deep in the bergschrunds. … A minor cooling (e.g., -3 °C) results in bergschrund temperatures that are dominantly within the frost cracking window" (Sanders et al., 2012, p. 781). Mass wasting readily feeds the frost-loosened material onto the glacier for transport.

Many glacial deposits are short lived, especially when overrun by new glacial advances or glaciofluvial processes. Some prominent moraines formed by the large Skeiðarárjökull in Iceland vanished in jökulhlaups (Grove, 1988).

Glacial Deposits

Certain types of unconsolidated sediments, particularly unstratified deposits, have been considered glacially diagnostic, but more recent research has found most of these to be *equifinal* (the same end product can be produced by more than one process) or *polygenetic* (more than one process involved in forming the deposit). Historical records are needed to resolve these questions conclusively, and more for the Little Ice Age have thankfully been found of late (Anonymous, 2012; Connor et al., 2009; Nussbaumer et al., 2011).

Extent of Little Ice Age Deposits

In general, Little Ice Age deposits are greater in magnitude than deposits from the past century but considerably less than those inferred to have occurred during the Great Ice Age. This is true throughout our study area, as well as elsewhere in the world.

The south coast of Iceland has been changed dramatically since *Landnám* (in the Medieval Warm Period), primarily through deposition of sediment into broad, flat, outwash plains extending from the mountains to the sea and often crossed by braided streams. These are called *sandar* (singular *sandur*). The largest is Skeiðarársandur (Figure 4). Significant bays and inlets have been nearly or completely replaced by *sandar*, e.g., Hjörleifshöfði (Landnåmsboken, 1997, p. 47). While some of the erosion and deposition preceded or followed the Little Ice Age (Klevberg and Oard, 2012a), probably the greater part happened during the Little Ice Age.

Till

One of the most abundant glacial deposits is till, but the word "till" is a genetic term, describing the mode of deposition. Till is usually unstratified, a diverse mix-

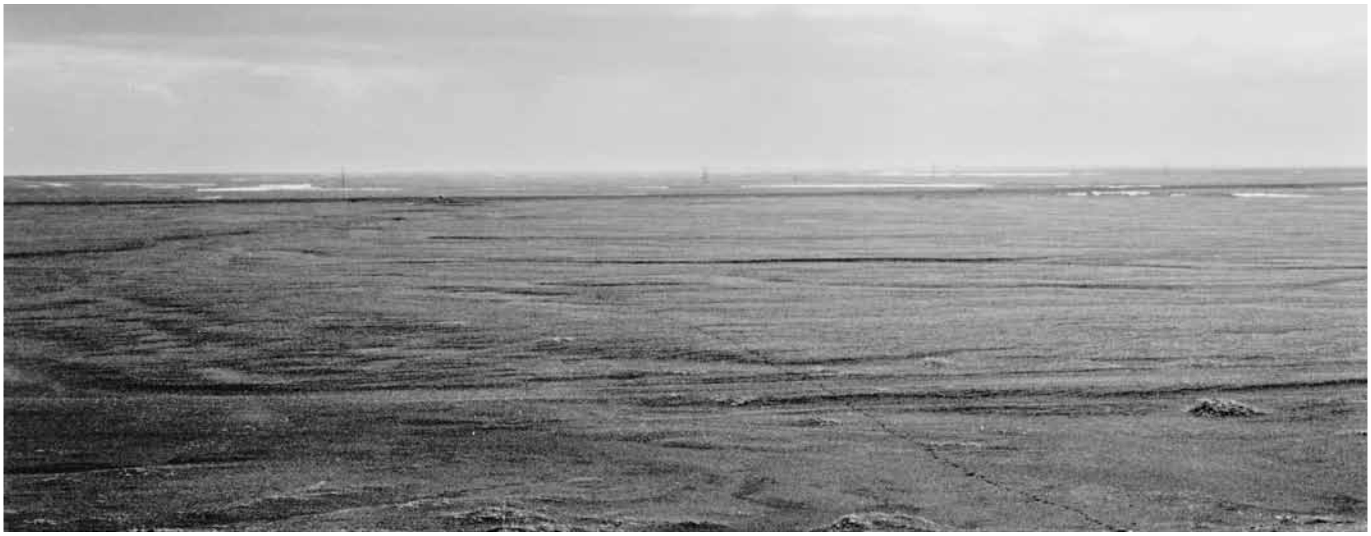

Figure 4. Skeiðarársandur, the world's largest *sandur*, photographed from the southwest in 2002.

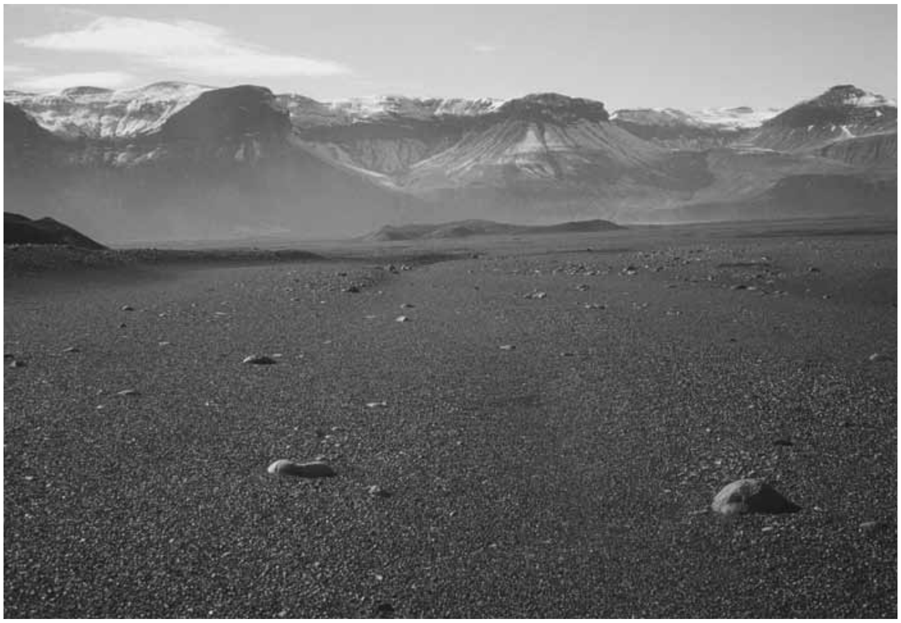

Figure 5. View west-northwest across Skeiðarársandur from inside (north of) Skeiðarárjøkull end moraine. Mountains rise abruptly 1,000 m (3,300 ft.) from edge of plain. Moraine complex has been nearly eliminated by jökulhlaup erosion and redeposition. Photographed in 2002.

ture of particle sizes from clay to gravel, most often with a fine-grained matrix (Figure 6). An unstratified and diversely graded mixture of unconsolidated sediment is a *diamict*, which is a scientific (i.e., descriptive) term with no genetic implication. Thus, nearly all till is diamict, but not all diamict is till. Many deposits have been used as evidence to argue for ice ages millions of years ago, a concept that has been refuted elsewhere (Molén, 1990; Oard, 1997).

Till (i.e., glacially deposited diamict) at Fjallsjökull displays layers of deformed materials, sometimes with identifiable unconformities (Rose et al., 1997). "Stationary glacial margins in Iceland are capable of superimposing numerous till layers to produce large composite moraines" (Evans and Twigg, 2002, p. 2167). Larsen and Mangerud (1992, p. 166) stated, "Till is only deposited beneath ice at the pressure melting point." To at least a limited extent, sediment can be transported into the englacial environment by being frozen to the base of the glacier and then thrust up and over other blocks of ice (Croot, 1988; Kjær and Krüger, 2001) or folded and incorporated into the glacier (Hambrey and Glasser, 2003). Where cliffs adjoin glaciers, mass wasting processes can efficiently deposit material on top of the glacier. After transport via ice, melting can deposit the material in an unstratified condition. Multiple till layers are known to form by these processes (Evans and Twigg, 2002).

Surging may affect the character of till. Kjær et al. (2006) investigated till from Brúarjökull, an outlet glacier

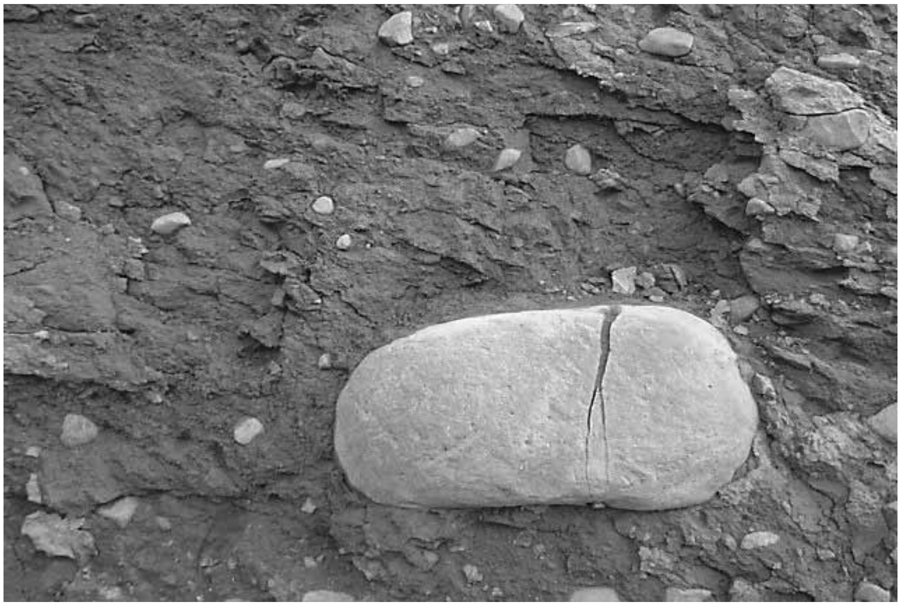

Figure 6. Lodgement till in drumlin, Sólheimajökull forefield, photographed in 2004 (from Ingólfsson, 2008).

on the northeast side of Vatnajökull (Figure 2) and stated, “Beneath the till plain, the 6 m of glacial sediments were accumulated during multiple surge advances and retreats as indicated by superimposed till beds interbedded by sorted sediments and the signature left by several generations of deformation” (p. 2707). The thin shear zone was evidenced by truncated upper drag fold flanks and shear-rotational structures and overturned folds. Ductile-brittle deformations extend down to the bedrock surface, however, so not all deformation was limited to the thin upper shear zone. Water-lain “interlaminated sediments” parallel the bedrock surface and truncate the base of the overlying sediments, indicating high subglacial porewater pressures during surges.

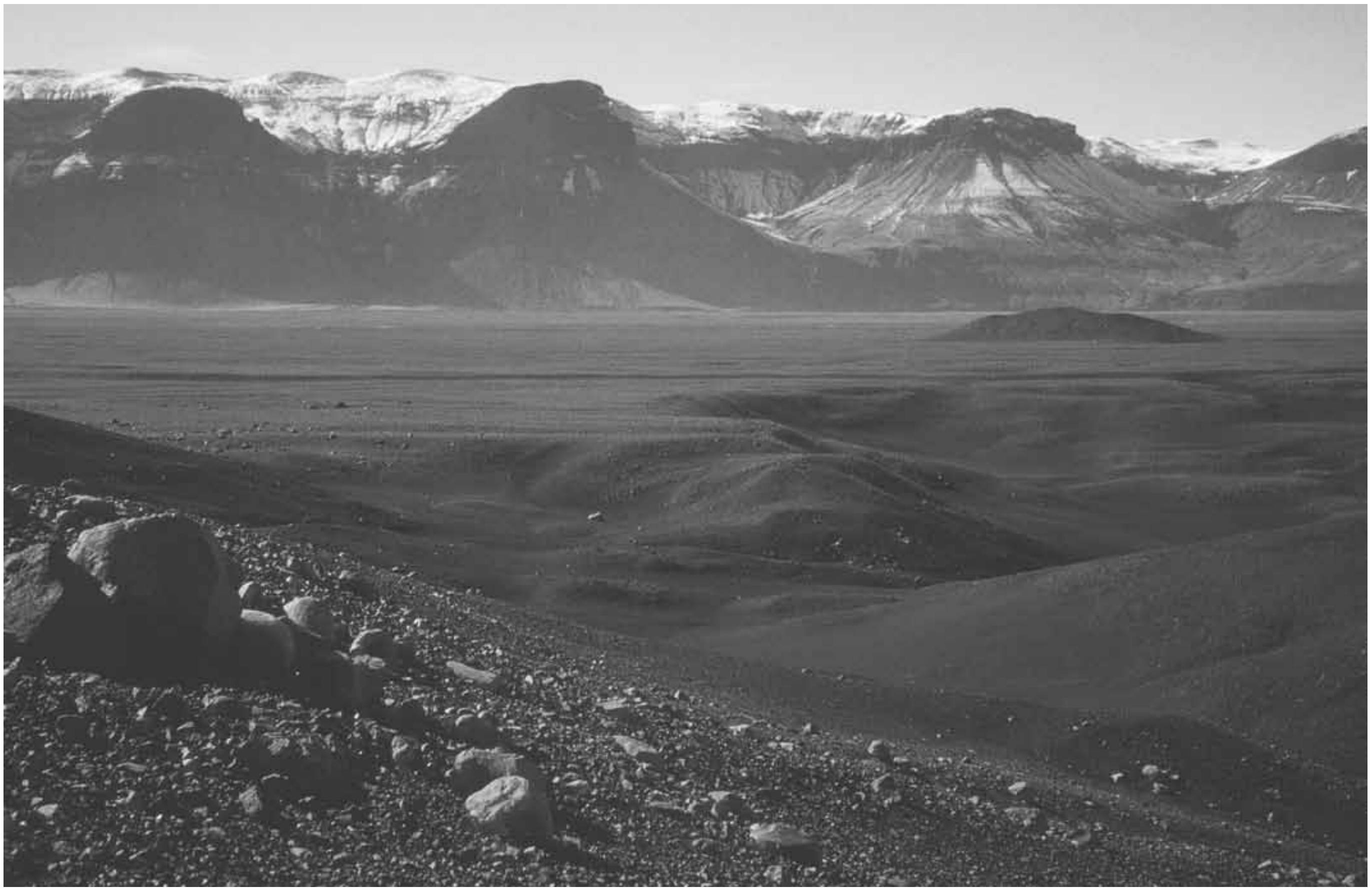

Figure 7. View west-northwest across Skeiðarársandur from Skeiðarárjøkull end moraine. Boulders have been transported by ice (foreground) and jökulhlaups (visible on sandur surface). Photographed in 2002.

a great deal (Figure 9). Fabric strength should therefore be used as one clue among many of the possible origin of a deposit; it is not a diagnostic criterion. Poorly sorted, structureless, matrix-supported deposits, massive deposits, and clast-supported fabrics have been documented to form in recent times from outburst floods and not just by means of glacial transport mechanisms (Rushmer, 2006). However, stratification alone is not diagnostic of fluvial processes, either. "Basal ice processes are dominated by entrainment of ice and sediment from the cavity floors, and compressive deformation of existing basal ice, to produce a complex stratified sequence" (Knight et al., 2007, p.208). Sediments in the jökulhlaup channel "are indicative of rapid rising stage deposition of sediment-rich flows" (Rushmer, 2006, p. 47), the rapid deposition resulting from "a rapid loss of transport capacity and mass suspension sedimentation" (p. 48). These nonstratified jökulhlaup deposits are associated with clearly fluvial deposits such as gravel foresets and horizontally bedded gravel units or diffuse gravel sheets. "The dominance of *a*-axis-parallel clast orientation within the structureless deposits at Kverkfjöll, additionally reflects rapid deposition from highly concentrated flows, whereby non-Newtonian processes occur within an overall turbulent, fluidal, Newtonian flow" (Rushmer, 2006, p. 48). Hyperconcentrated flows have been observed in other jökulhlaups (Figures 2 and 10).

> In the Ejyafjallajökull eruption, peak discharge and peak sediment flux were decoupled, and the dominant ice-proximal surface landforms are the result of a series of late-stage, lower discharge jökulhlaups over a period of weeks. … At Ejyafjallajökull, a changing source water:sediment ratio and proximal flood routing produced different flood rheologies. (Dunning et al., 2013, p. 1125)

Till fabrics can be relatively strong. Those observed in deposits from the

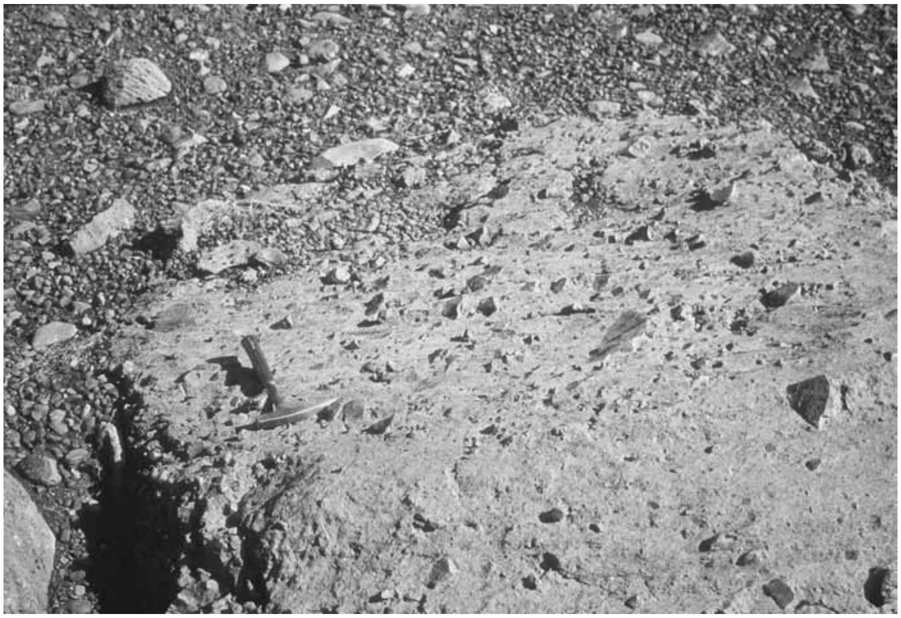

Figure 8. Breccia boulder deposited by Skeiðarárjökull, photographed in 2002.

Boulders

"Lodged and striated boulders are ubiquitous" in Breiðamörk deposits (Evans and Twigg, 2002, p. 2159), and "the large percentage of striated clasts and the clast roundness and shape … indicate considerable clast wear in the basal traction zone of the glacier" (p. 2164). Bullet-shaped clasts have been observed to be abundant in Múlajökull channels (Johnson et al., 2010), a typical example of the often intimate association of glacial and glaciofluvial processes. While angularity can serve as a clue to glacigenic versus nonglacigenic boulders, boulders transported by warm-based ice can be rounded (Owen et al., 2010), and angular materials (e.g., rip-up clasts) can be eroded and deposited by jökulhlaups (Waller et al., 2001). Large clasts may be excavated by ice but transported by a variety of mechanisms (Figures 7 and 8). Boulders of several tons have been transported great distances by ice avalanches and debris flows generated from mountain glaciers (Kellerer-Pirklbauer et al., 2012). Obviously, significant elevation difference is needed to provide the potential energy to drive these processes.

Varves

Varves are supposedly annual pairs of laminae in sediments deposited downstream of glaciated areas. There appear to be some present-day lakes that act adequately as sediment traps from glaciated areas to produce true varves (Schiefer et al., 2006); however, most alleged varves are natural history conjectures and often refuted by other field evidence (Molén, 2008; Oard, 2009). Rhythmites (alternately laminated sediments) can be produced by a variety of processes, including turbulent deposition (Berthault, 1994) and should not be assumed to have been deposited as varves.

Fabrics

Till depositional histories have been differentiated on the basis of fabric strength (Dowdeswell and Sharp, 1986). As has been shown from deposits in Montana, USA (Klevberg and Oard, 2005), glacigenic and nonglacigenic fabrics overlap surging Icelandic Brúarjökull are stronger in the center of flutes (eigenvalues average 0.80±0.04) than the sides (0.65±0.08) according to Kjær et al. (2006). Thus, fabric data can be very useful but also very problematic and nondiagnostic for inferring mechanisms of transport and deposition.

Ice avalanches and debris flows generated from glaciers can produce clast orientation. Orientation of the *a*-axis (long axis) of clasts parallel to flow with imbrication either upstream or downstream (depending on the site) has been observed in a debris flow from Nördliches Bockkarkees in Austria, as has till pebble orientation either parallel to or transverse to ice flow direction (Kellerer-Pirklbauer et al., 2012). Fabric measurement from a study location at Nördliches Bockkarkees produced eigenvalues matching deformation till in Figure 9.

Recent efforts to discriminate between subglacially and supraglacially transported clasts using statistical analysis of percentages of angular and rounded rocks appear promising (Reinardy et al., 2013). It may also have wider application (Kellerer-Pirklbauer et al., 2012). Additional research will be needed to ascertain the degree of reliability and usefulness of this method (Figures 11–13).

Other

Flutes are present on the upgradient side of moraines deposited by the Little Ice Age in Iceland (Evans and Twigg, 2002) and Norway (Owen et al., 2010; Reinardy et al., 2013). They may result from till squeezing into cavities in ice on the downstream side of boulders (Figure 14). Fluted terrain is present behind the Little Ice Age moraines at Midtdalsbreen (Hardangerjøkulen) and Tverrbytnede (Jotunheimen) in Norway, but not beyond these moraines (Owen et al., 2010; Reinardy et al., 2013). Brúarjökull has produced “a streamlined till plain superimposed on larger bedrock

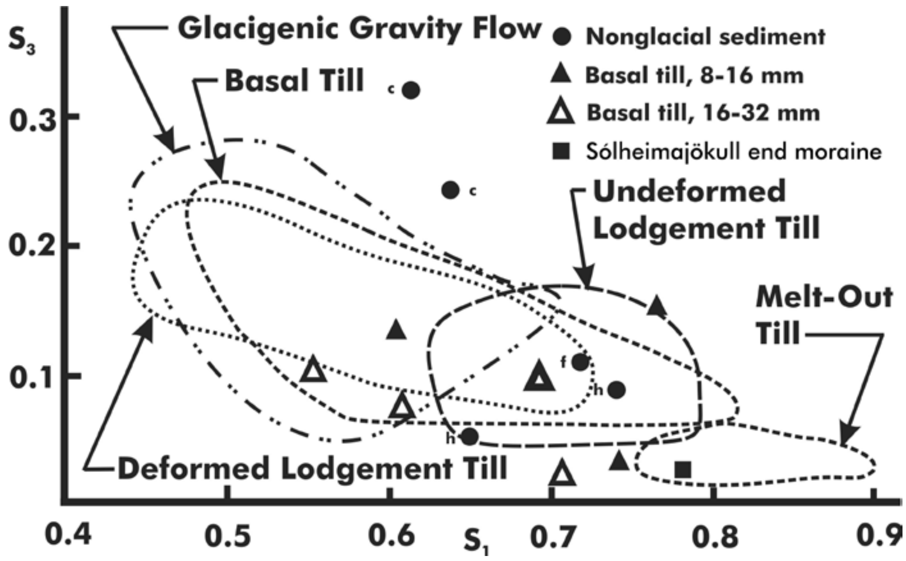

Figure 9. Fabrics in unconsolidated sediments can be useful indicators of probable origin, but they are not diagnostic. Fabric strength envelopes from Dowdeswell and Sharp (1986). These were derived primarily from Breiðamerkurjökull (See Figure 2 for locations). Nonglacial fabrics (·) from Klevberg and Oard (2005): c—colluvium, f—fluvial floodplain gravel, h—hypothetical (computer-generated fluvial). Also shown are basal till fabric data from 1980 surge of Vestari-Hagafellsjökull (Carr and Goddard, 2007) for 8–16 mm fraction (▲) and 16–32 mm (Δ), and end moraine fabric from Brynjólfsson (2004) left after the advance of Sólheimajökull that ended in 1995 (■).

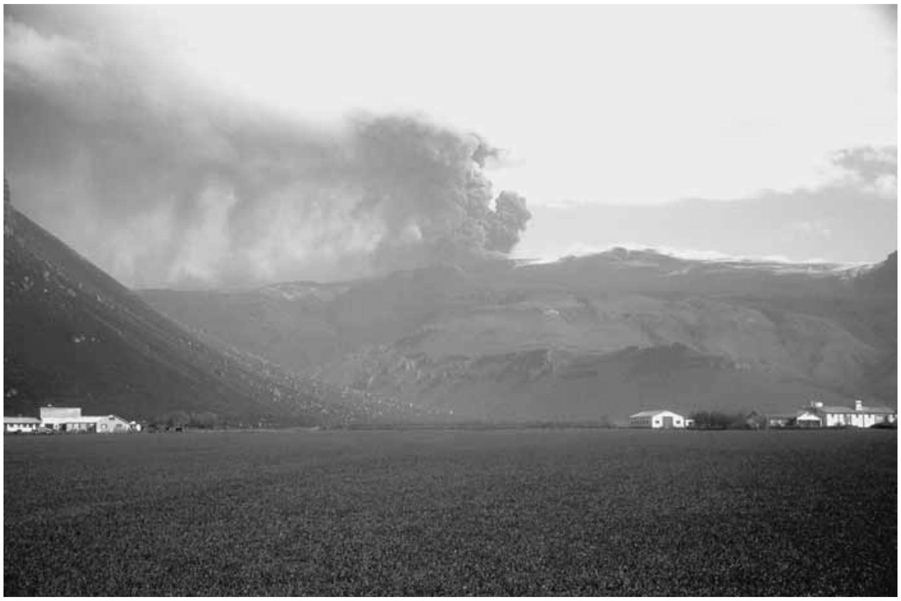

Figure 10. Eyjafjallajökull during eruption of May 2010. Jökulhlaups caused by this eruption produced a great many useful sedimentation data. Photograph by Helge Klevberg.

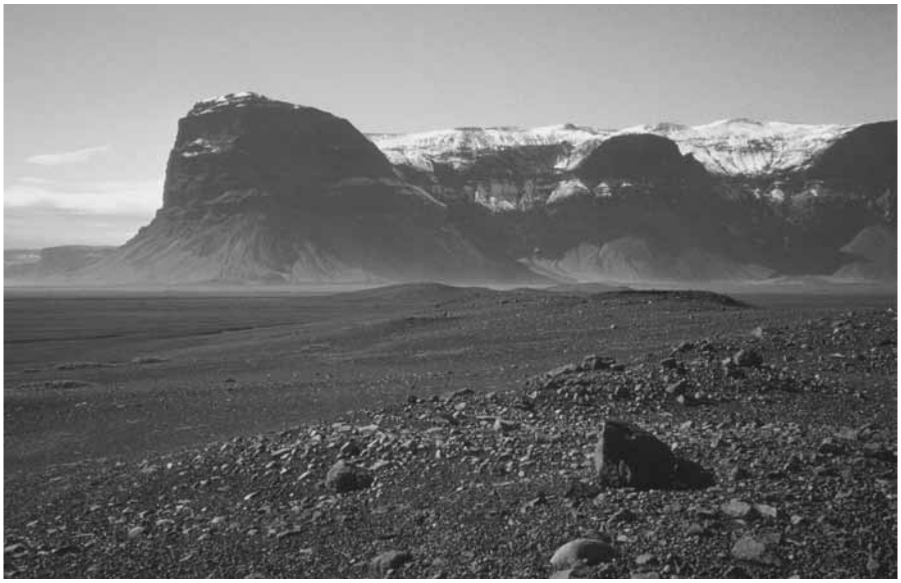

Figure 11. View west from end moraine of Skeiðarárjøkull (Figure 1) in 2002, showing typical gravel composed of rocks of mixed angularity.

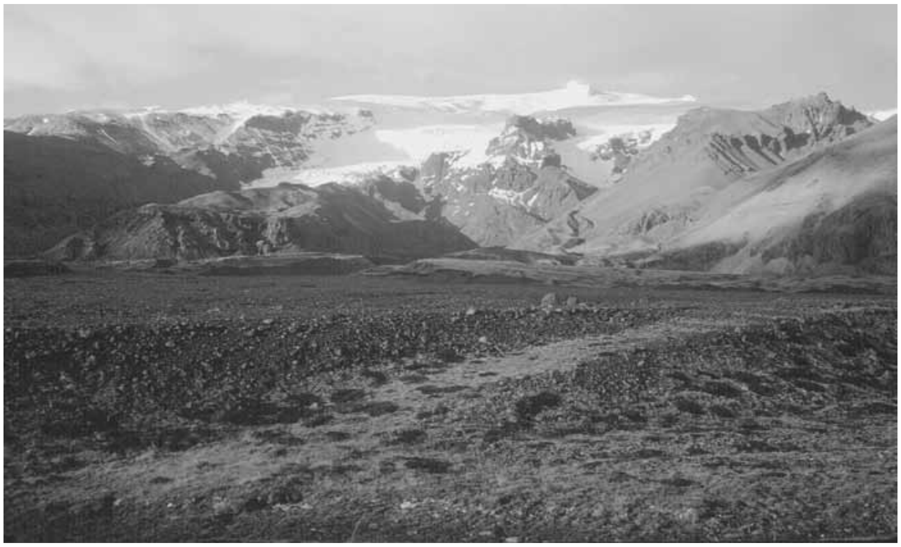

Figure 12. Coarse gravel deposits from glaciers in vicinity of Öræfi. Photographed in 2002.

features and subglacial landforms" (Kjær et al., 2006, p. 2707). Flutes sometimes exceed 1.5 km in length and result from boulders. Fluted terrain that is erosional, rather than depositional, is present in Canada (Shaw et al., 1996).

Clastic dikes have been observed in Little Ice Age and recent deposits; these are interpreted as evulsion features from overpressured water (Evans and Twigg, 2002; Kjær et al., 2006). Larsen and Mangerud (1992) showed that many features interpreted as ice wedge casts may actually be clastic dikes. While till can certainly fill cracks in underlying sediment, clastic dikes may form subglacially by till being squeezed into cracks in the overlying sediment. Clastic dikes may also result from injection of a slurry and may form stratified or laminated crack fillings. Hydraulic splitting from subglacial water pressure cracks the host sediments. Till dikes sometimes have laminated off-shoots or grade into laminated dikes with distance from the source, indicating fluidity and sorting of the sediment during emplacement. Impregnation of host material with fines from slurry along dike margins indicates host material was not frozen, though clastic dikes could certainly also form in frozen sediments. In at least some cases, glacigenic clastic dikes may differ from nonglacigenic clastic dikes solely in the origination of the former from relief of overpressured subglacial water through cracking of subjacent sediments and dissipation of the pressure. Water escape structures (evulsion structures) have been reported for till strata formed during or after the Little Ice Age (Johnson et al., 2010).

Glacial pavements may have been generated by subglacial winnowing (Evans and Twigg, 2002). Post-Little Ice Age till with a pebble-size clast pavement has been observed from Múlajökull in Iceland (Johnson et al., 2010). Pebble-armored slopes have been observed to develop in Greenland from deflation of fines on moraine slopes, and boulders accumulate at slope toes (Knight et al., 2007).

Glacial Landforms

Glacial landforms may be depositional or erosional. Depositional types are often of smaller scale but more varied than erosional landforms. Glacial processes and movements are often inferred from depositional fabrics and landforms, but all are known to have been produced during the Little Ice Age and the subse-

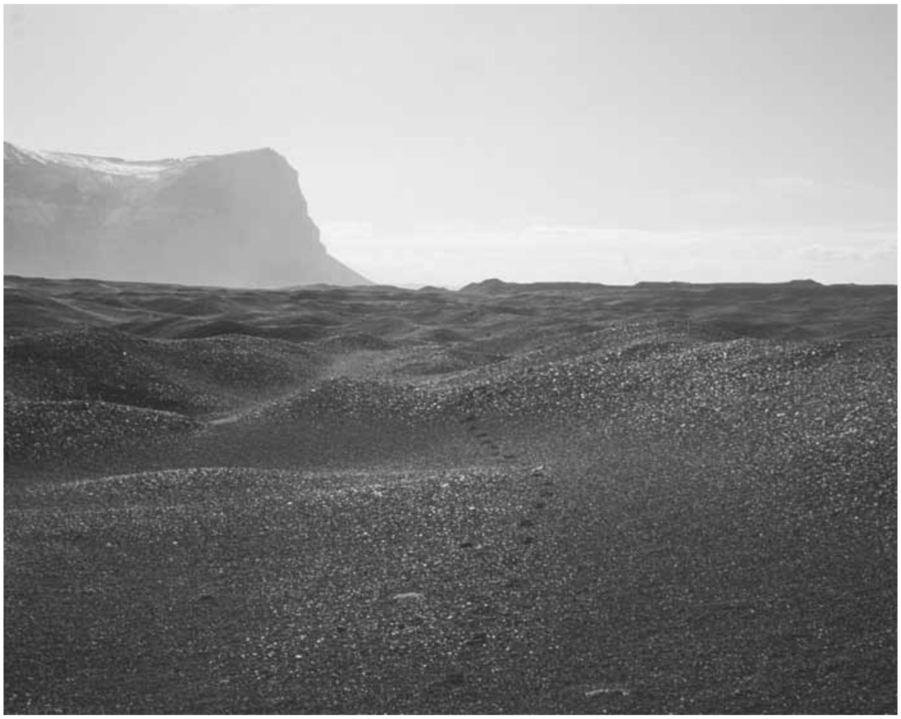

Figure 13. Skeiðarárjökull moraine complex, showing predominance of well-rounded gravel. Footprints provide scale. Photographed in 2002.

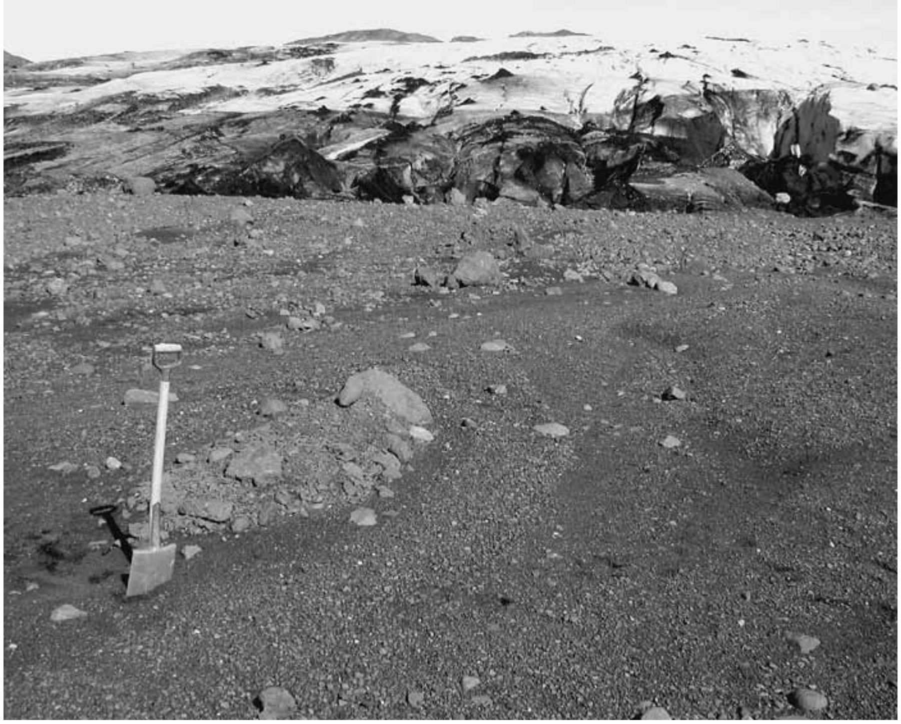

Figure 14. Small flute in front of Sólheimajökull, 2004 (photograph from Ingólfsson, 2008).

quent glacial recession (Andrzejewski and Molewski, 2007; Decaulne et al., 2007; Price, 1969).

Moraines

Moraines are one of the most prominent glacial landforms (Figure 15). Prominent moraines from the Little Ice Age and later are well documented (Figure 16).

Evans and Twigg (2002), in their investigation of Little Ice Age deposits on Breiðamerkursandur, found that moraines were largely mosaics of many small deposits:

> The maritime, cold-temperate climate of the region is probably responsible for the late winter readvances of the receding glacier margins in southeast Iceland … thereby giving rise to the deposition of numerous, often annual, recessional push moraines. (p. 2145)

They posit the prominent moraine Brennhóla-Alda is a thrust moraine (thrust block) with older peat plastered on top. "Thrust moraines in Iceland are associated exclusively with surging margins … and constitute a major land element in the surging glacier landsystem" (Evans and Twigg, 2002, p. 2157). They interpret low, intermediate ridges in Iceland as overridden moraines, either from earlier in the Little Ice Age or before it. Such subdued ridges have been observed to form in this manner (Knight et al., 2007).

Kjær et al. (2006) studied the surging Brúarjökull. They opine that water escape pits at heads of stream channels indicate transition from ground water to surface water. Where water escaped the subsurface through more permeable sediments, shear likely increased and may explain the formation of end moraines:

> The widespread occurrence of hydrofractures within the Brúarjökull forefield implies evacuation of large quantities of meltwater along the substrate/bedrock interface, which

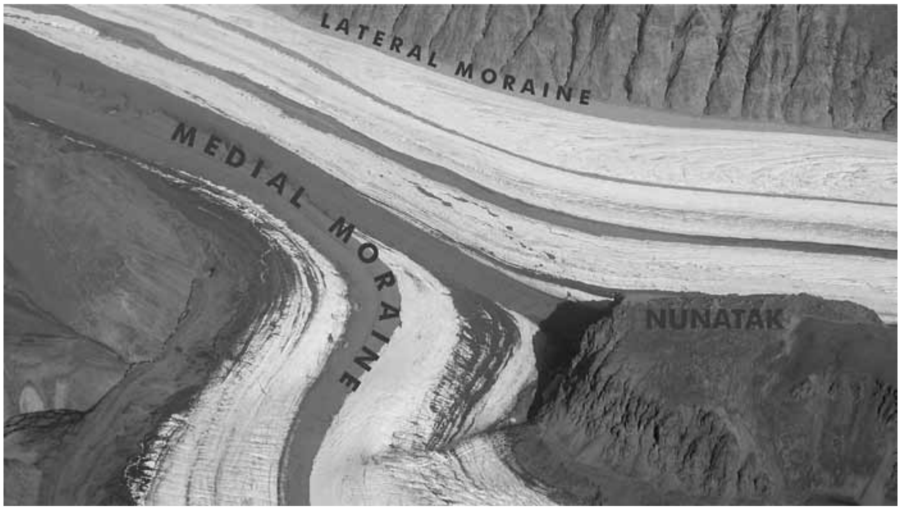

Figure 15. Moraines and Nunatak on Nuussuaq Peninsula, Greenland. Base image from Wikipedia Commons.

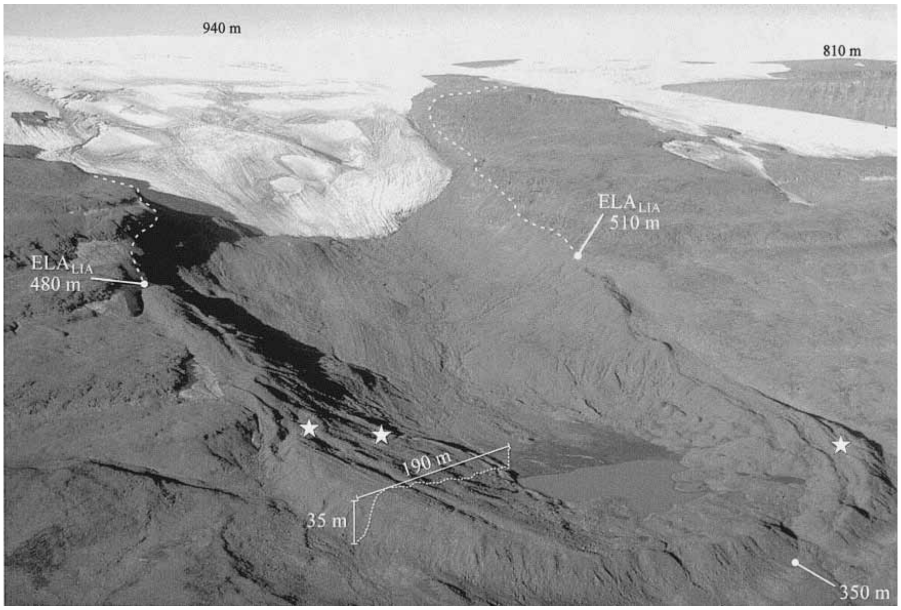

Figure 16. Moraines from Little Ice Age with equilibrium line altitude (ELA) contemporary with moraine formation indicated. Rock glacier on southwest Diskø, Greenland (Figure 1). Star symbols represent sampling locations. Figure from Humlum (2000).

> suggest that overpressurized water carried both the sediment burden and the weight of the glacier" (p. 2711).

Ice marginal moraines can be formed by glacial "bulldozing," running water, or a combination (Lukas, 2012). Converging ice at glaciers on Spitsbergen (in Svalbard) produce folding and foliation to generate medial moraines, thus forcing sediment to the surface (Hambrey and Glasser, 2003). In 1890, Brúarjökull surged 10 km and piled up a push moraine 20 m high (Björnsson, 1980).

Hummocky moraines from Breiðamerkurjökull and Fjallsjökull appear to result from deposition as medial moraines or from glacial reworking (Evans and Twigg, 2002). Burial of large pieces of ice in moraines will produce hummocky terrain when the ice melts (Figures 17 and 18).

Drumlins

Drumlins are streamlined landforms that project above the surrounding land surface (Figure 19). Drumlins are a salient feature among landforms ascribed to glaciation, and some have been produced by the Vatnajökull outlet glaciers.

> A number of drumlins, most of which are spindle types up to 1 km in length, occur on the foreland of east Breiðamerkurjökull and are superimposed by flutings and push moraines. … Former outwash fan apices have developed into stiff drumlin cores, resulting in the partial preservation of ice-contact glacifluvial fans beneath streamlined till surfaces. (Evans and Twigg, 2002, pp. 2159, 2174)

As shown in Part III of this series (Klevberg and Oard, 2012a), these are Little Ice Age features. Perhaps the only example of drumlin formation in recent decades is from Múlajökull, where small drumlins formed subglacially through a combination of till deposition, deformation, and erosion where the ice experienced compressive flow near the glacier's margin and high subglacial water pressure (Johnson et al., 2010). Small drumlins (and large flutes) have been observed in modern environments (Figure 20).

While drumlins are known to form subglacially, not all drumlins are neces-

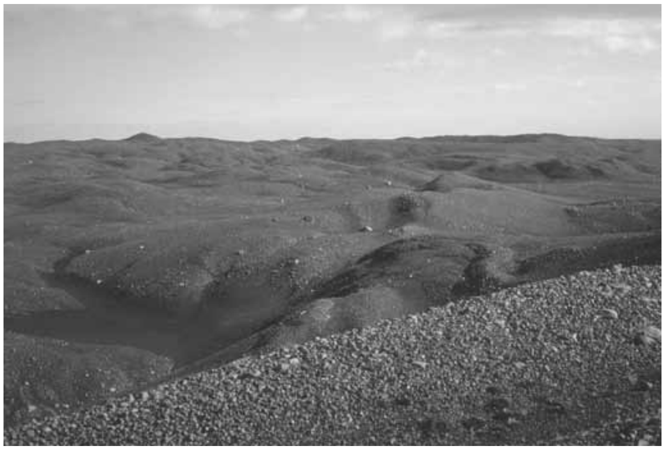

Figure 17. Skeiðarárjökull moraine complex as it appeared in 2002.

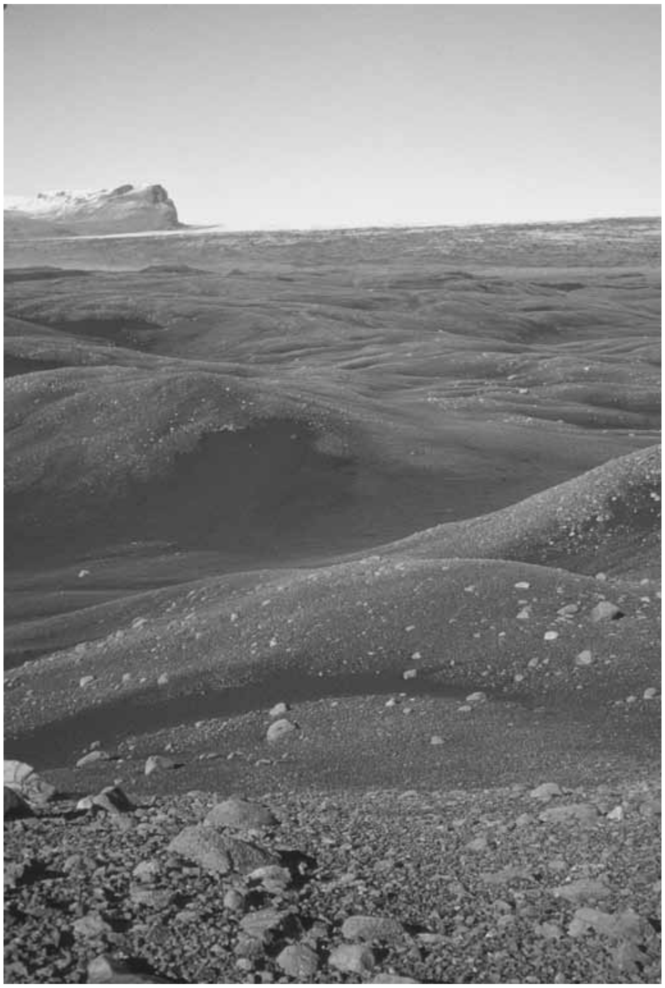

Figure 18. View north toward Skeiðarárjökull from moraine field in 2002.

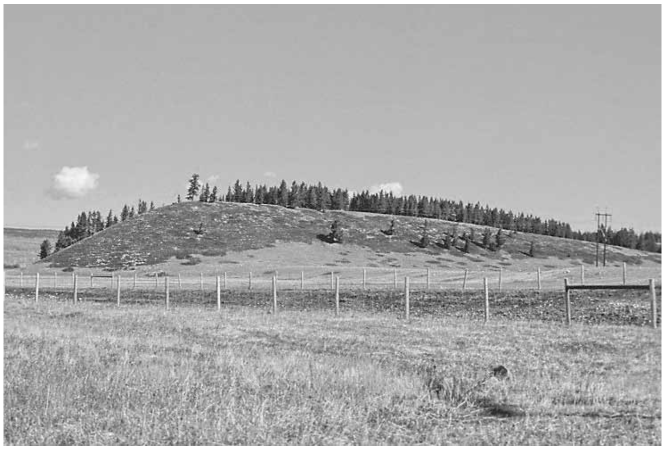

Figure 19. Famous drumlin at Morley Flats, Alberta, Canada. Photograph posted by University of Lethbridge.

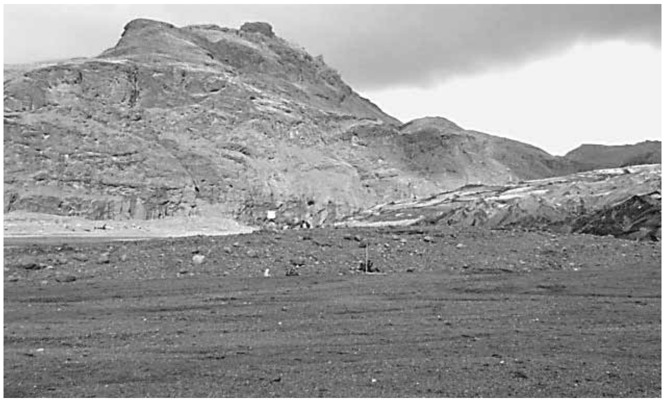

Figure 20. Small drumlin in the Sólheimajökull forefield, photographed in 2004 (from Ingólfsson, 2008).

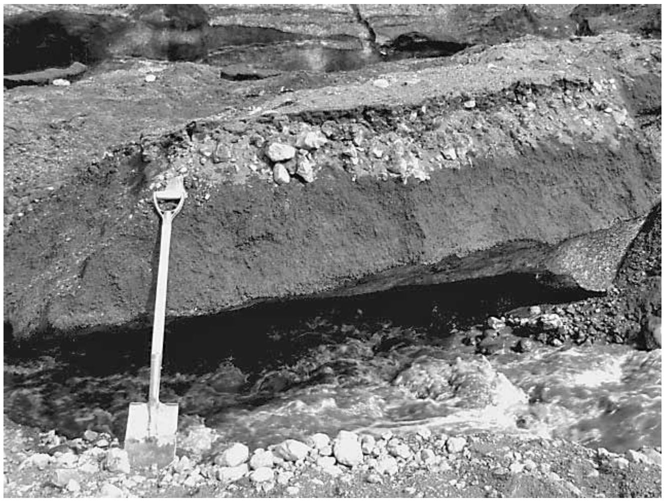

Figure 21. Supraglacial debris on Sólheimajökull in 2004 (from Ingólfsson, 2008).

sarily primarily depositional. Shaw and Sharpe (1987) cite drumlin fields where stratigraphy can be traced through multiple drumlins, indicating these formed erosionally. A prime example they give is from Beverley Lake, Nunavut (formerly the Canadian Northwest Territories), but other areas with what appear to be erosional drumlins are also found.

"The apparent lack of modern drumlin fields may not necessarily indicate that modern glaciers differ from Pleistocene ice sheets, but that current glaciers, most having reached their maximum during the Little Ice Age, have not yet retreated far enough to reveal them" (Johnson et al., 2010). Differences in depositional drumlins between the Great Ice Age and Little Ice Age largely devolve to size, number, and extent of drumlin fields. We are not aware of modern analogues for erosional drumlins.

Eskers and Hummocky Terrain

Where steep mountain glaciers are concerned, debris can readily accumulate on the glaciers' surfaces from rock fall and landslides off the adjacent cliffs, but this mechanism does not operate in areas of low relief or areas buried by ice. As noted by Evans and Twigg (2002), it is difficult to conceive of how debris could get on top of glaciers such as those they studied in Iceland so that eskers could form under normal conditions (some eskers have ice cores). They posit surging as the only ready explanation. Surging glaciers could conceivably pick up considerably more debris as they repeatedly advance and retreat, often with large amounts of meltwater released (Figure 21). Jökulhlaups have been observed to provide not only these sudden surges of subglacial, englacial, and supraglacial water, but also to transport sediment up onto the glacier's surface (Waller et al., 2001). Shearing may also occur between sediment frozen to the base of a glacier and deeper, unfrozen sediment, with thrusting of ice slabs permitting limited incorporation of sediment into the ice, as has been observed with annual moraine formation (Boulton, 1970). Esker formation has also occurred directly as the result of jökulhlaup deposition (Russell et al., 2007), though "normal" formation by bedload deposition from englacial streams has also been documented (Figure 22).

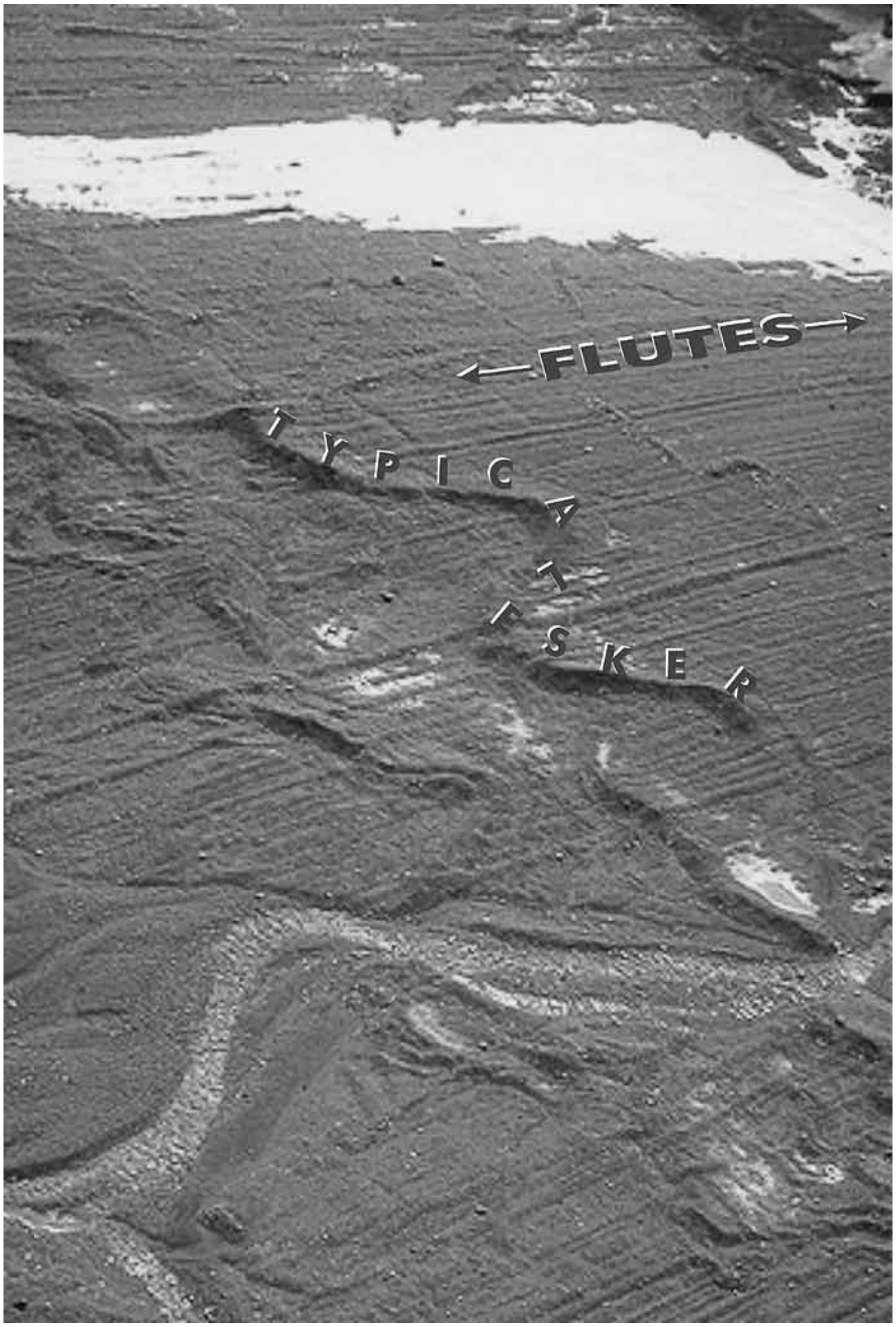

Figure 22. Flutes and eskers indicated on aerial base image of Bear Glacier, Kenai Peninsula, Alaska. This forefield lies behind the Little Ice Age terminal moraine. Base image from Eastern Illinois University (http://www.ux1.eiu.edu/~cfjps/1300/glacier_photos.html).

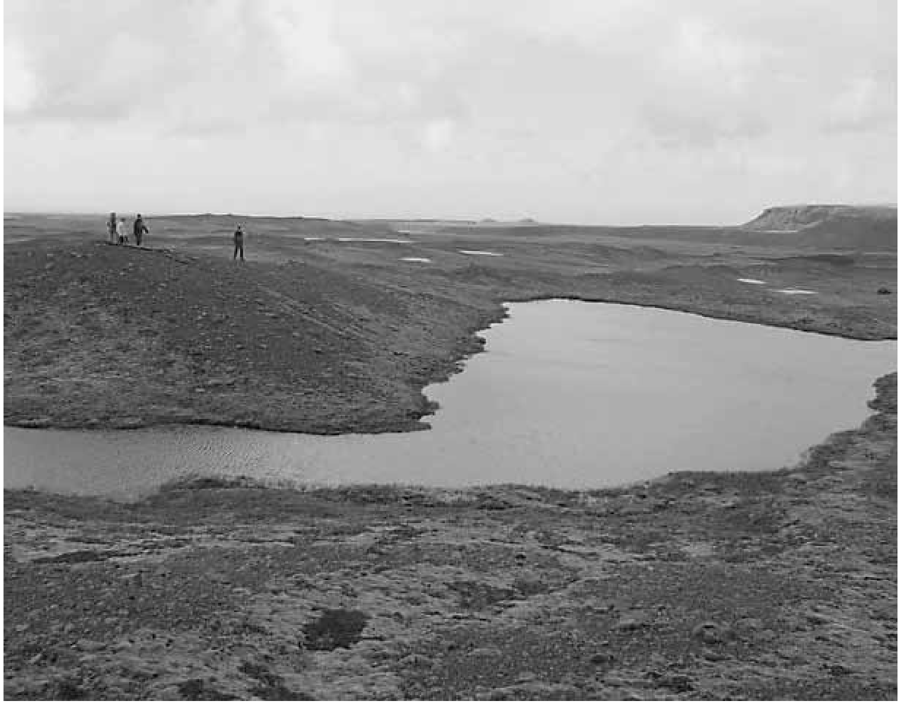

Figure 23. Kettle-hole lake, Little Ice Age moraines, in 2004 at Sólheimajökull (from Ingólfsson, 2008).

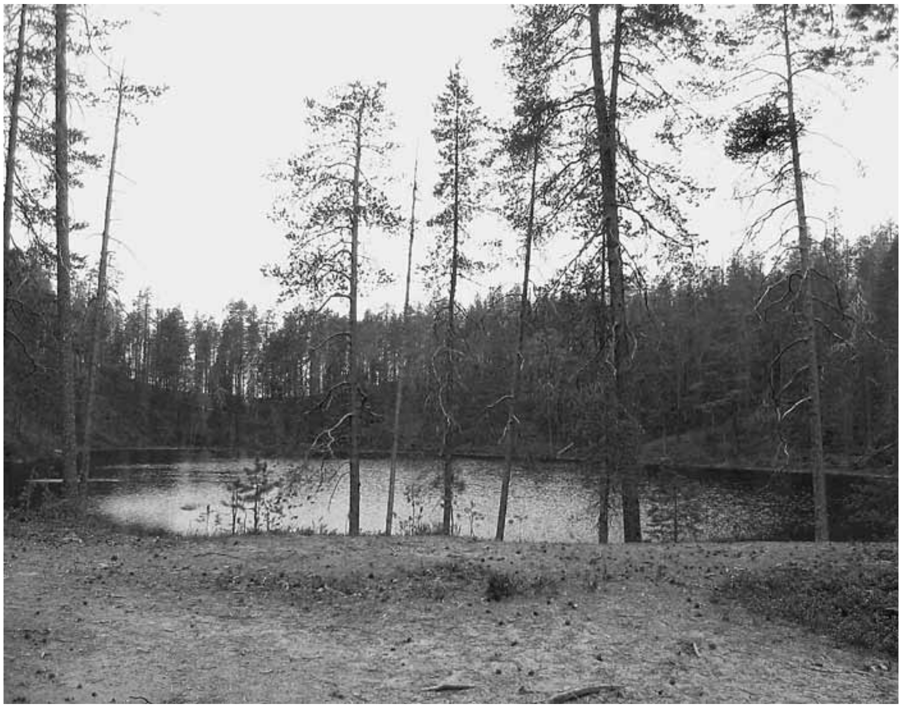

Figure 24. A typical kettle-hole lake in Finland (image from Wikipedia Commons).

Hummocky, "dead ice topography" is a less ordered result of a similar process to esker formation. Hummocky terrain from the Little Ice Age has been reported from Midtdalsbreen in Norway, where meltout of inverted topography was observed (Reinardy et al., 2013). Hummocky terrain was also produced by jökulhlaups in Iceland in 2010 depositing mixtures of ice and sediment (Dunning et al., 2013).

Kames and Alluvial Terraces

Thompson and Jones (1986) observed paired (both sides of stream) and unpaired river terraces on the southwest side of Öræfi (Figure 2), attributable to Little Ice Age glacial fluctuations and a 1727 jökulhlaup. Subjacent sediments from the eruption and jökulhlaup of 1362 provide dating control. Up to 28.5 m of sediment was eroded by Kotá stream erosion since 1727 to form a series of terraces cut in the "dead ice" topography of the 1727 (uppermost) surface. Svinafellsá is incised as much as 7.9 m to form five paired terraces. Svinafellsjökull retreated in 1870. Contemporary kame formation was reported from elsewhere in Iceland (Molewski et al., 2007; Szmanda et al., 2007). Aggradation appears related to advance or stagnation of the glaciers, accelerated downcutting with rapid retreat. The rate of downcutting has been related to the rate of retreat or the rate of sediment supply. Virtually all of this work was performed by glaciofluvial or jökulhlaup processes rather than glacial ones. Multiple terraces have been produced by single jökulhlaups (Rushmer, 2006) and multiple jökulhlaups (Dunning et al., 2013).

Kettles, Rock Glaciers, Outwash Plains

Kettles are known to form where glaciers bury large blocks of ice that later melt out to form the prominent holes known as kettles (Figures 23 and 24). Less well known is the fact that kettles can form

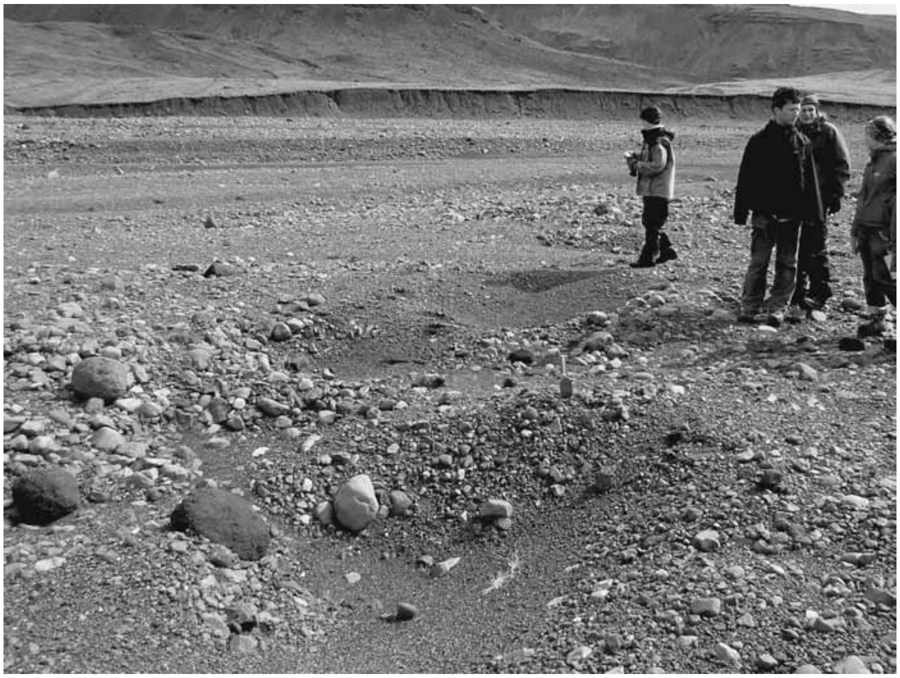

Figure 25. Pitted sandur surface after melting of ice debris deposited during the 1999 Sólheimajökull jökullhlaup, photographed in 2004 (from Ingólfsson, 2008).

from ice blocks buried by jökulhlaups (Dunning et al., 2013; Rushmer, 2006).

Ice-cored moraines (Evans and Twigg, 2002) and rock glaciers (Martin et al., 1991) are not uncommon to this day in Iceland as well as in Greenland (Figure 16), though even in the colder subcontinent rock glaciers appear to result from the unusual climatic conditions of the Little Ice Age (Humlum, 1998; Owen et al., 2010). Ice-cored moraines generally date from the Little Ice Age, though some may be from more recent advances.

Outwash plains are proglacial plains of glacial drift. They typically are crossed by anastomosing flood channels and braided streams. The *sandar* of Iceland are often shaped largely by jökulhlaups (Figure 25). These sometimes deeply rework existing strata and sometimes simply bury them.

> Based on the stratigraphic evidence and bedrock topography discovered above, it is clear that Breiðamerkurjökull and Fjallsjökull advanced during the Little Ice Age over considerable tracts of glacifluvial outwash without disrupting their general form. … This suggests that sandur fans are relatively stable forms that become adorned with subglacial features such as drumlins and flutes during glacier overriding but remain dominant as topographic features. (Evans and Twigg, 2002, p. 2168)

Where erosional features formed, they tend to be dramatic. Maizels (1991) argues that the large Skeiðarársandur farther west probably originated more from catastrophic jökulhlaups than from ordinary fluvial processes, though ordinary fluvial processes are also known to accomplish much work in relatively short periods of time (Price, 1982; Price and Howarth, 1970). The 1934 Skeiðarársandur jökulhlaup is estimated to have released 10 to 15 km^3 of water (Grove, 1988), and the 1996 jökulhlaup involved a peak flow of about 52,000 m^3 s^{-1} and transported an estimated 60 million m^3 of sediment (Smith et al., 2000). There have been many others (Ives, 2007). Both glacial and glaciofluvial processes are at work forming these outwash plains (Figures 26 and 27).

Overdeepened Valleys

The Little Ice Age provided dramatic evidence of the cutting power of glaciers. Trenches were cut by Breiðamerkurjökull (Figure 28) to depths as much as 300 m below sea level in basalt bedrock (Evans and Twigg, 2002)!

> During the very rapid retreat after 1930 proglacial lakes have formed in front of Skeiðarárjökull and Breiðamerkurjökull. The largest lake is Jökullsárlón on Breiðamerkursandur which reaches 120 m below sea level. The material released from the glaciers has not been sufficient to fill up the lakes. (Björnsson, 1980, p. 209)

The most notable, Jökullsárlón (Figure 29), is not the only example of this impressive erosional phenomenon. "In fact, the base of several of the larger glaciers extends below sea level" (Ives, 2007, p. 205). Retreating glaciers have left other impressive basins that have formed lakes: Fjallsárlón, Breiðárlón, and Stemmulón on Breiðurmörk (Figure 2). Most other proglacial lakes are shallow. The Jakobshavn Isbræ in western Greenland discharges through a trough 1,200 to 1,500 m below sea level, though this trough may well predate the Little Ice Age (Roberts and Long, 2005).

Bedrock Forms

Glaciers may plane, polish, and scratch bedrock surfaces. They may also create streamlined forms where knobs of rock resist the flow of the ice. Glacial recession since the end of the Little Ice Age has revealed streamlined roche mountonnées (with rough or plucked lee ends) and whalebacks (with smooth, unplucked lee ends) at Jakobshavn Isbræ in Greenland. This glacier drains

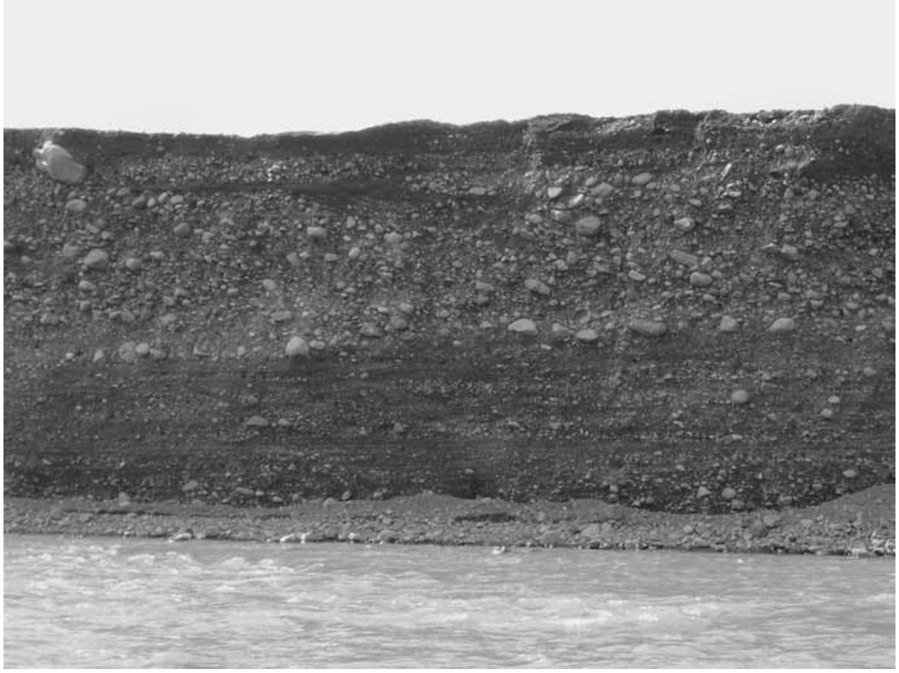

Figure 26. Stratified sandur deposit, Sólheimajökull forefield, photographed in 2004 (from Ingólfsson, 2008).

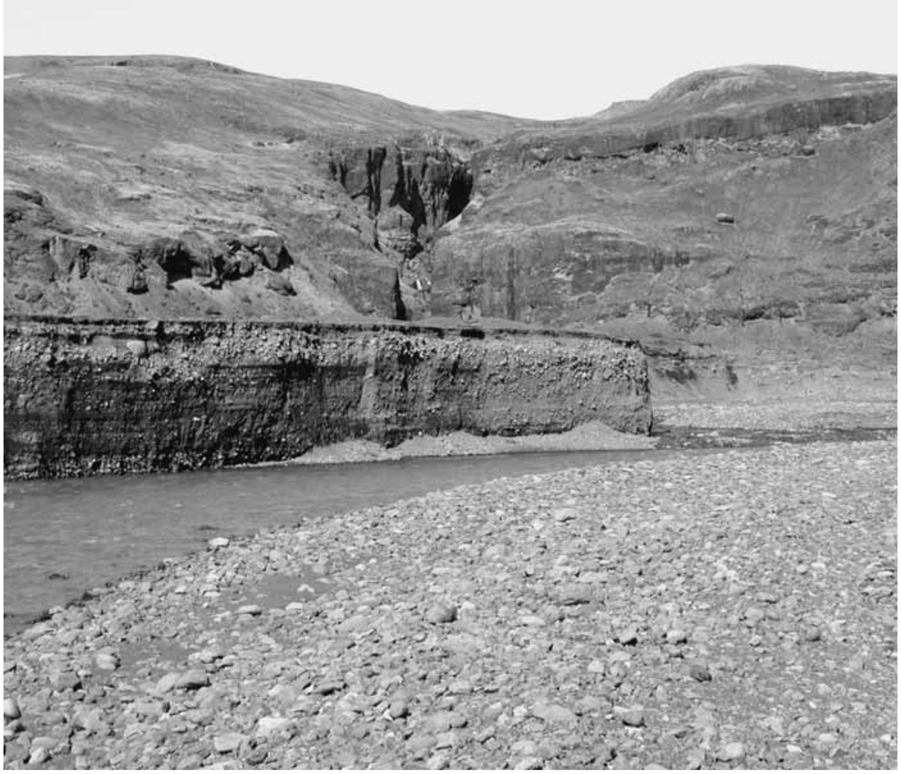

Figure 27. Stratified outwash gravels and sands, Sólheimajökull, photographed by H. Norðdahl in 2004 (from Ingólfsson, 2008).

approximately 7% of the Greenland Ice Sheet (Roberts and Long, 2005). The roche mountonnées and whalebacks developed in an area of high glacial velocity but likely differing ice thickness (i.e., differing vertical pressure). These observations from Greenland indicate "the major controls over plucking are bed separation and cavity opening, pressure melting, fluctuations in subglacial water pressure and refreezing. [Whaleback] morphology suggests that bed separation, cavity formation and plucking do not occur during their formation" (Roberts and Long, 2005, p. 26). Striations, roche mountonnées, and whalebacks recorded two or more flow directions at Jakobshavn Isbræ. Little Ice Age glacial movement smoothed hard gneiss bedrock at Fåbergstølsbreen over the course of approximately one hundred years (Owen et al., 2007).

Patterned Ground

Patterned ground has been observed to form where glaciers have retreated from their Little Ice Age maximum extent (Ballantyne and Matthews, 1982). Some have speculated the size of the periglacial forms (cf. permafrost circles) is related to age, but it appears these patterns can form within just a few years, with pedogenesis and vegetative stabilization hindering or halting development with time (Haugland, 2006). The size of the circles or polygons relates strongly to conditions conducive to frost heave, especially microclimate and sediment grain size distribution (Feuillet and Mercier, 2012).

Patterned ground in the form of rock circles in the Rondane Mountains of Norway is associated with solifluction lobes and block fields. Block fields in south-central Norway are common, but erratic boulders are rare, and block fields tend to be on high terrain, higher than diamict interpreted as till (Follestad and Fredin, 2007). They may therefore have been produced by periglacial or nonglacial processes.

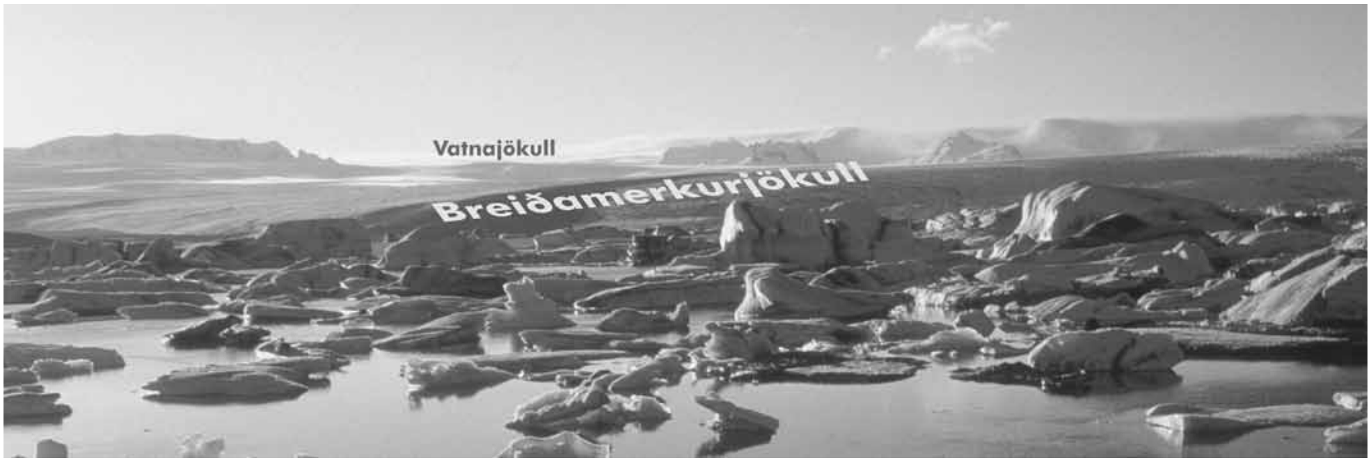

Figure 28. View northwest toward Breiðamerkurjökull in April 2002.

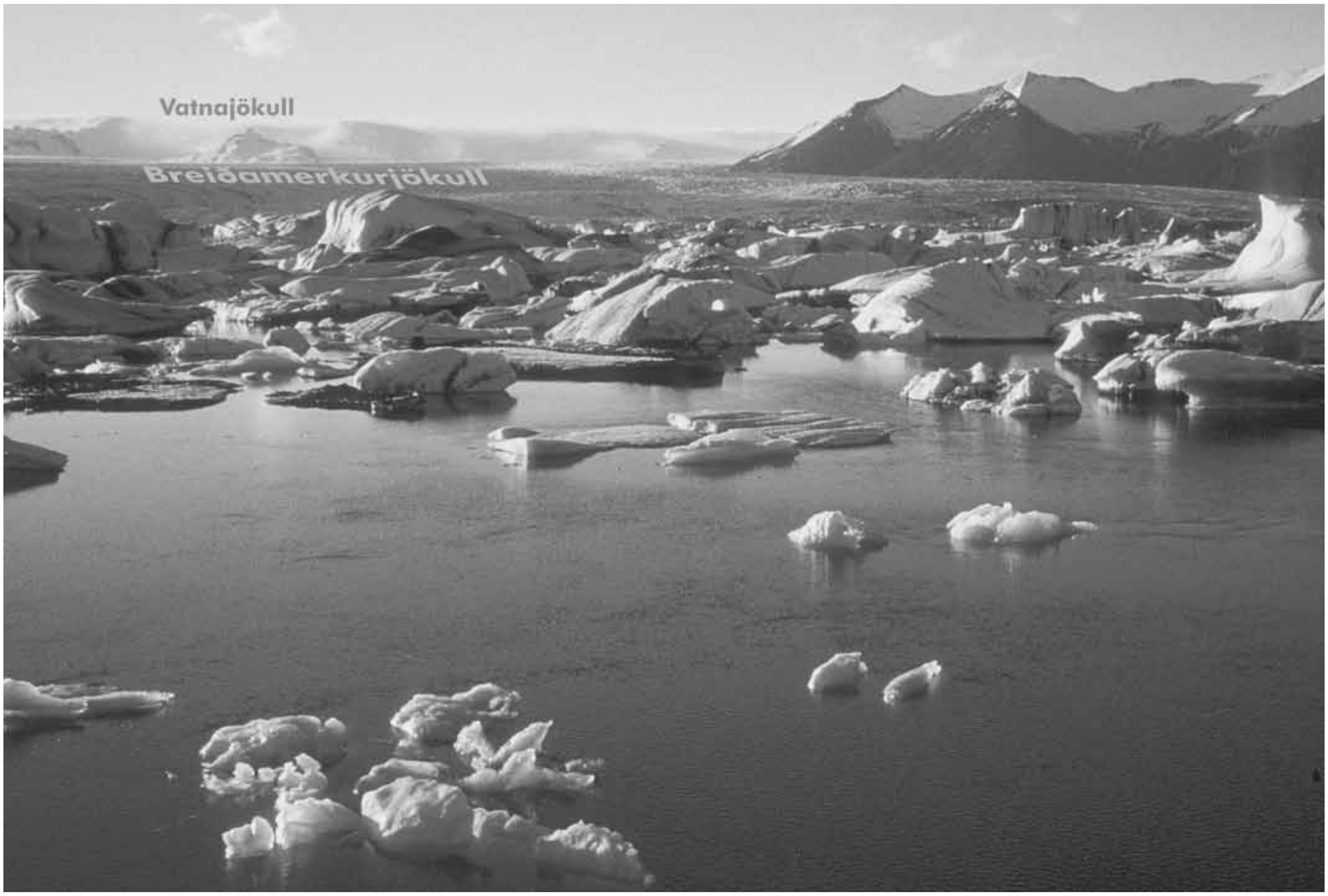

Figure 29. Jökulsárlon, the proglacial lake at the foot of Breiðurmerkurjökull on the southeast side of Vatnajökull (Figure 2), which was eroded well below sea level.

Glacial Movement and Processes

As a very viscous fluid, ice is capable of excavating and transporting large volumes of earth materials. This was particularly evident in Iceland and Greenland during the Little Ice Age. The power of glaciers to erode and deposit sediment was observed during the Little Ice Age, is observable today, and is inferred for the Great Ice Age. Paleocurrent indicators for glacial movements, such as moraines, boulder trains, and intermixed diamictons, are present in the Oslofjord of Norway, on the Canadian prairies, and the upper states of the United States, for example, places that were not touched by permanent ice during the Little Ice Age.

Flow Rates and Processes

Rates of ice flow can vary markedly. Speaking of the Vatnajökull outlet glaciers in Iceland, Björnsson (1980, p. 205) states, "Velocities of over 1 m/day are common." Kjær et al. (2006) have studied Brúarjökull, a northern outlet glacier of Vatnajökull that surged over a period of three months during winter followed by 70 to 90 years of quiescence. The surges occurred in 1890 (10 km) and 1963 (8 km), "affecting an area of roughly 1400 km^2 … The peak velocity was at least 125 m/day over a period of almost three months" (Kjær et al., 2006, p. 2705). This involved an estimated 40% of the area of Vatnajökull (Björnsson, 1980). Subsequent retreat was passive.

Surging glaciers exhibit the following transport modes: basal sliding (decoupling at ice/sediment interface), deformation of water-saturated subglacial sediment (the deformable bed model), and as at Brúarjökull, a dual-coupled model (glacier coupled to bed, sediment deforms, and sediment decouples from impermeable bedrock). Sediment deformation tends to be thin and discontinuous based on modern observations and laboratory experiments (Kjær et al., 2006).

Much geologic work may be associated with surging glaciers, of which many have been identified. Very large surges of Brúarjökull, Skeiðarárjökull, and Breiðamerkurjökull have been documented (Grove, 1988; Ives, 2007). Cold-based glaciers (i.e., those frozen to their beds) necessarily flow at slower rates than warm-based or polythermal (mixed) glaciers. This has a significant bearing on the amount of geologic work that may be accomplished in a given period of time. Lateral meltwater channels have been used to infer cold-based or polythermal ice, but temperate (warm-based) glaciers also exhibit these (Syverson and Mickelson, 2008), and glacial work that has been attributed to cold-based ice may actually have been accomplished by warm-based ice (Reinardy et al., 2013). Experiments under the west lobe of Breiðamerkurjökull identified two layers: an upper layer that is dilatant and flows ductilly and a lower layer that flows by brittle or brittle-ductile shearing. "It was calculated that more than 90% of the forward movement of the glacier was produced by this deformation of the substrate" (Evans and Twigg, 2002, p. 2159). Iverson et al. (2003) performed experiments using the Svartisen subglacial laboratory in Norway to measure basal traction stresses beneath the glacier and stated, "Our results are not consistent with common assumptions regarding basal movement of glaciers. Data from the soft-bed experiments indicate that high pore-water pressure may weaken the ice-till interface more than till at depth, causing slip of ice over the bed" (p. 83). Thus, actual glacier movement may be more and erosion beneath glaciers shallower than commonly estimated. Surging is limited to warm-based glaciers and is episodic. Kuannersuit Glacier in western Greenland (Diskø) surged 10.5 km between 1995 and 1998 (Yde and Knudsen, 2005), and even larger surges have been measured. Surging can greatly accelerate geologic work, even accomplishing in a day what might ordinarily require a year or a decade (Benediktsson et al., 2007). Basal melting can result not only in surging but also in detachment and transformation into debris flows, such as occurred in Russia in 2002, where the Kolka Glacier reached a maximum velocity in the range of 65 to 80 m/s (Evans et al., 2009)!

Water-ice interaction is very important. Evidence has been presented for thinning of outlet glaciers in eastern Greenland from decreasing basal friction resulting from increased water (Krabill et al., 1999). Cowton et al. (2012) summarize their work in western Greenland:

> We have presented a detailed study of the sediment flux and associated current rate of erosion of a large catchment beneath the Greenland ice sheet. Across the catchment, which covers an area of ~600 km^2 and extends to more than 50 km from the ice sheet margin, we calculate a subglacial erosion rate of 4.8 ± 2.6 mm a^{-1}. This is 1–2 orders of magnitude higher than previously reported rates. … Our data therefore challenge the notion that erosion below polar glaciers and continental ice sheets is dominated by slow mechanical processes associated with ice advance and retreat. … Instead, we find that the efficient subglacial drainage of surface meltwater is critical in creating a zone of rapid erosion around the margins of the ice sheet. (p. 346)

Sediment Accumulation and Transport

Mass wasting processes are important in providing sediment for supraglacial and englacial transport (Owen et al., 2010; Porter et al., 2010) and for modifying glacial landforms (Knight et al., 2007; Sanders et al., 2012). Sediment is frequently deposited and then re-entrained by new glacial advances (Burki et al., 2010; Knight et al., 2007; Lukas, 2012), often destroying previous fabrics and landforms. The efficiency of these processes for entraining sediment is highly dependent on topographic relief to provide the driving potential energy.

Seasonal change in glacier thermal regime can be an important means of enhancing erosion as the sediment freezes to the bed of the glacier during the winter and then is transported through a combination of glacial thrusting and glaciofluvial processes during the warmer months, often forming annual moraines (Croot, 1988; Kjær and Krüger, 2001; Krüger, 1985, 1993, 1995, 1996; Reinardy et al., 2013). Studies of the Russell Glacier in western Greenland show "the debris-rich basal ice layer is the dominant route for sediment transfer through the ice over long sections of the ice-sheet margin" (Knight et al., 2007, p.204). In the Breiðurmerkursandur area, stratified glaciofluvial sediments are overlain or disturbed by tills and glaciotectonites (Evans and Twigg, 2002).

Formation of glacial deposits tends to be highly episodic:

> When the margin lies behind a moraine ridge, glacigenic sediment is largely stored in the ice-proximal zone and distal sediment production is limited. As the margin overtops the moraine, distal sediment production increases markedly both because the opportunity for ice-proximal storage is reduced and because moraine sediments are reactivated. (Knight et al., 2007, p.214)

Multiple Directions, Multiple Glaciations?

Evidence of changes in direction of ice flow has been used by believers in old-earth chronology to argue for multiple ice ages (Oard, 1990), but observed changes in direction during and after the Little Ice Age indicate that a single event can produce striae, roche moutonnés, and other ice-flow indicators showing two or three distinct flow directions as thinning ice begins to be deflected by obstructions such as ridges and emerging nunataks (Roberts and Long, 2005; Syverson and Mickelson, 2008). Owen et al. (2010, p. 421) astutely observe, "For a variable period of time following glacier retreat, processes of landscape modification, erosion, sediment transport and deposition operate at rates greatly exceeding their 'normal,' background rates."

Glaciomarine Features

What are interpreted as iceberg scour marks on the bed of the North Sea and glacial features on the bed of the Norwegian Sea and the Barents Sea are attributed to the "Pleistocene" ice ages or, as we describe it, "The Great Ice Age" (Klevberg and Oard, 2012b; Mattingsdal et al., 2007). The Little Ice Age did not produce these subsea features (Klevberg and Oard, 2014c), probably partly due to effects of scale of processes and partly to differences in sea level contemporary with glaciation. However, scour marks and glaciomarine deposits were formed on a smaller scale during the Little Ice Age, suggesting the processes were the same, though different in scale.

Interpreting Apparently Glacial Features

As described in Part VII (Klevberg and Oard, 2014c), the Little Ice Age is a useful but imperfect model for the Great Ice Age. Glacial processes and periglacial processes sometimes coincide and sometimes do not. Follestad and Fredin (2007) opine,

> It appears that many glacial landscapes in Scandinavia have more in common with landscapes formed at modern polar ice caps, as for example in Arctic Canada and Russia … than with landscapes formed at modern temperate glaciers on Iceland and in Scandinavia, which traditionally have been used as analogues for former Fennoscandian ice sheets. (pp. 281–282)

Any model is imperfect, and science is limited in its role in natural history research (Reed, 1999; Reed and Klevberg, 2014a, 2014b). Thus, apparent glacial deposits and landforms remain solely apparent except where historical research can confirm their origin. The inference is more likely where a given deposit or landform occurs in association with other likely glacial features.

One must also keep in mind that even during the Little Ice Age, other geologic forces were at work. Forces that were involved in noticeable changes to the Icelandic landscape between *Landnám* and the Little Ice Age—tectonics, erosion, volcanic eruptions (Pálsson, 2000)—did not cease during this glacially active period. Many geologic features from recent centuries may be the result of a multiplicity of processes. For example, Little Ice Age glacial erosion produced post-Little Ice Age mass wasting many places (Owen et al., 2010; Matthews and Shakesby, 2004). Reinardy et al. (2013) state:

> Preservation potential also differs from landform to landform. Detailed geomorphology and sedimentology are commonly used to interpret palaeoglacier dynamics and their climatic implications. … Midtdalsbreen provides an interesting modern analogue in which some of these assumptions can be tested. Thus, the chronological evolution seen within the geomorphological record at Midtdalsbreen may simply reflect the difference in preservation potential between different landforms … rather than a significant change in glacier dynamics. (pp. 907–908)

Glaciation Can Produce Many Fluvial Deposits

Canadian researchers have shown that many features traditionally attributed to glacial processes are likely the result of glaciofluvial or purely fluvial processes (Shaw and Sharpe, 1987; Shaw et al., 1996), including percussion marks, which are clearly nonglacial (Klevberg and Oard, 1998). Sometimes it is difficult to discern between glacial and nonglacial processes, as similar results can occur from different processes (i.e., equifinality). Polygenetic processes appear to be the rule rather than the exception in glaciated areas, both within and downstream of the ice margin.

The southern coast of Iceland at Mýrdalssandur grew between 2.2 and 2.5 km from 1660 to 1960 (Björnsson, 1980, p. 209). While some of this was directly attributable to eruptions of the Katla volcano, some of it was attributable to glacially induced erosion and to jökulhlaups resulting from volcanic-glacial interaction. Maizels (1991) attributes most of the sandur deposits to jökulhlaups. Major events appear responsible for most of the geologic work (Lawler, 1991).

> Most of the early settlements [on Mýrdalssandur] were destroyed by hlaups from Kötlujökull between the ninth and eleventh centuries. … The Kötluhlaup of November 1660 carried away all the houses and the church of Höfðubrekka, so that hardly a stone was left on the original site and so much material was carried down to the shore that a dry beach appeared where previously fishing boats had operated in waters 20 fathoms deep. (Grove, 1988, pp. 27–29)

Even on a much smaller scale, melting ice provides water for fluvial transport (i.e., glaciofluvial process) often in combination with glacial and mass wasting processes (Figure 30), which can produce glacial drift, including depositing nonstratified and complex moraines (Lukas, 2012). Sandar can be created and destroyed quickly, often catastrophically (Price, 1971).

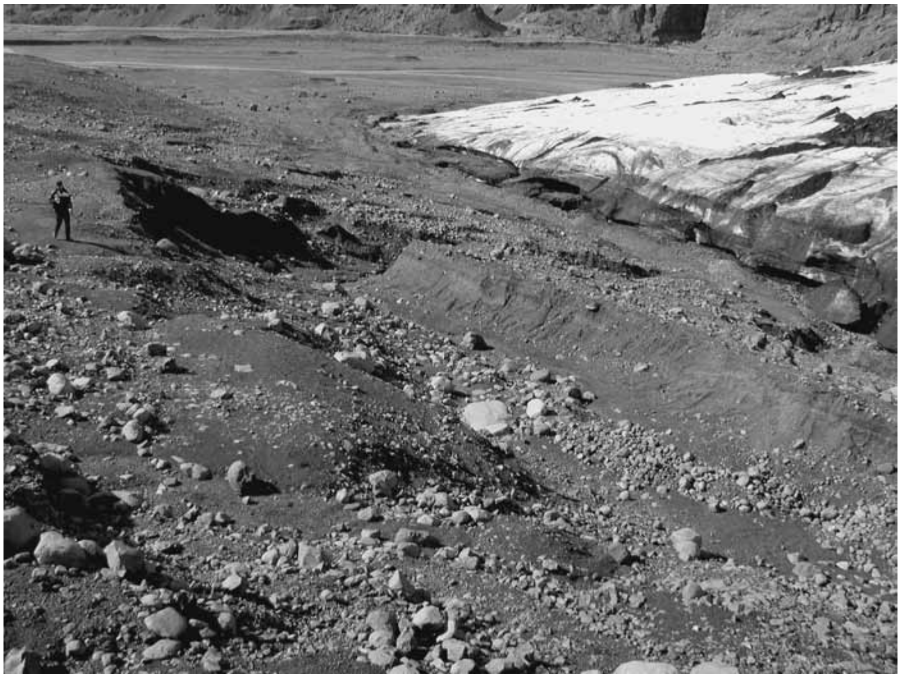

Figure 30. Meltwater channel at margin of Sólheimajökull, photographed by H. Norðdahl in 2004 (from Ingólfsson, 2008).

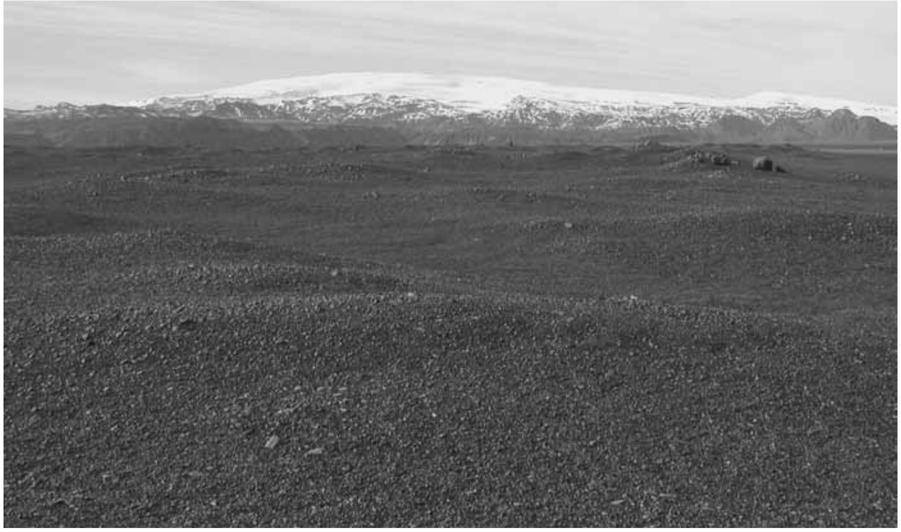

Figure 31. Megaripples in gravel formed on sandur south of Katla, Mýrdalsjökull in background. Photographed by H. Norðdahl in 2004 (from Ingólfsson, 2008).

Gerrard (1991) and Dugmore and Buckland (1991) believe anthropogenic factors have been more important than climate change in inducing mass wasting and soil erosion in Iceland, though individual situations vary widely. Deposits in Mediterranean Europe attributed to anthropogenic soil disturbance may be better explained by deluges (i.e., >200 mm precipitation in 24 hours) during the Little Ice Age (Grove, 2001), and geologic work since the Little Ice Age has been characterized by downcutting rather than deposition. In either case, the combination of lack of vegetation and heavy precipitation resulted in geologic work of much greater scale than is commonly observed today.

Large-scale geologic work could also occur if heavy rainfall combined with melting ice. This supports the general bias of diluvialists that geologic activity since the biblical Deluge has largely been of a considerably different character from diluvial processes, and even in the postdiluvian period has been largely dominated by episodic or catastrophic processes (Figure 31). Some of these may have been on a scale far larger than those with a traditional old-earth bias are willing to consider (Oard, 2004; Shaw et al., 1996; Shoemaker, 1995).

Summary and Conclusions

Geologic history is natural history, not observational science, and is therefore speculative. Historical data from the Little Ice Age and subsequent centuries provide us with good checks on our assumptions and inferences regarding the Great Ice Age. The inference is more likely where a given deposit or landform occurs in association with other likely glacial features and less so where the given deposit or landform is the only glacial indicator.

1. Observed glacial deposit and landform types generally compare favorably with what are commonly accepted as Great Ice Age features, though the latter are significantly greater in extent.
2. Rates of weathering and transport during the Little Ice Age were often much higher than expected based on traditional old-age scenarios for the "Pleistocene" ice ages. Chemical weathering, with ages often inferred based on ratios of cosmogenic isotopes, is likely less and physical weathering more than commonly assumed. This has been illustrated from sites in Norway and Greenland.
3. Relatively minor cooling (3°C) would be adequate to greatly hasten bergschrund development in Rocky Mountain glaciers. Presumably similar results could be obtained elsewhere in the world.
4. Not all diamict is till. Diamict has been deposited in recent decades by jökulhlaups. Likewise, some till or glacial drift is stratified. Stratification or lack thereof does not constitute an adequate criterion to determine if a deposit is glacigenic. "Pre-Pleistocene ice age" deposits probably formed mostly as submarine landslides.
5. Boulders were shaped, transported, and deposited by many processes during the Little Ice Age. In many cases, multiple processes were involved (i.e., polygenetic), while effects were the same for different processes (i.e., equifinality), meaning only historical data could differentiate processes.
6. True varves have been observed forming in some extant proglacial lakes, though most laminated sediments are not varves, and many classic "varve" sequences are not annual layers.
7. Fabric analyses are not diagnostic but can be helpful in conjunction with other criteria to determine the most probable mode(s) of origin of a given deposit. Additional research may improve shape and fabric methods, though one cannot expect them to be adequate to discriminate among all potential modes of origin.
8. Depositional flutes are observed at locations in Norway and Iceland from the Little Ice Age but not from the proglacial landscape in front of the Little Ice Age moraines. Erosional flutes are observed in Canada, where they predate the Little Ice Age.
9. Clastic dikes sometimes form where unfrozen sediment provides an outlet for overpressured subglacial water. Clastic dikes form where sediment infills crack. This sediment is sometimes diamict, sometimes laminated or stratified, and shows transitions from one to the other.
10. Glacial pavements formed during and after the Little Ice Age from current winnowing and deflation of fines.
11. Moraines often form on an annual basis in front of retreating glaciers and sometimes form more rapidly before surging glaciers. Moraines frequently form from juxtaposition of small, heterogeneous deposits and may be polygenetic. Source material may be transported via any combination of subglacial, englacial, and supraglacial routes and glacial, glaciofluvial, glaciotectonic, fluvial, and mass wasting processes. Where ice is incorporated into the moraine, a hummocky surface typically develops.
12. Depositional drumlins did form in Iceland during the Little Ice Age. Though they are rare, it is possible that more will appear as glaciers recede. Erosional drumlins are also known, but these predate the Little Ice Age. Great Ice Age drumlins are larger, more numerous, and of both depositional and erosional types. In some cases, subglacial megafloods appear the only plausible explanation proffered thus far.
13. Eskers were produced during the Little Ice Age by surging glaciers in combination with supraglacial streams and inverted topography, and also by jökulhlaups alone. Eskers are thus an example of equifinality.
14. Kames and terraces were developed during the Little Ice Age via glacial and glaciofluvial processes. Multiple terraces were observed to form from a single jökulhlaup.
15. Kettles formed during the Little Ice Age both glacially and glaciofluvially.

16. Rock glaciers occupy a narrow climatic niche and in at least some cases appear to be relict features from the Little Ice Age.
17. Outwash plains formed rapidly, episodically, extensively, and catastrophically during the Little Ice Age. Sandar in Iceland significantly altered the southern coastline.
18. Overdeepened valleys formed during the Little Ice Age. Jökullsárlón in Iceland was excavated between 120 and 300 m below sea level.
19. Hard bedrock was planed, polished, scratched, plucked, shaped into roche moutonnées and whalebacks, and ground down during the brief centuries of the Little Ice Age at rates far above those estimated for previous millennia by believers in the old earth paradigm.
20. Patterned ground quickly formed in permafrost areas following recession of glaciers. Periglacial processes formed rock circles and likely block fields.
21. Surging can greatly accelerate geologic work. Many glaciers have been observed to surge from more than a meter per day to as much as 10.5 km and possibly more. Some features that have been used to infer that glaciers were cold based are equivocal. Traction stresses are more related to pore water pressure than bed projections and may indicate faster ice transport, less bed shearing, and more bed deformation than previously thought. Where gradients are steep and glaciers detach from their beds, debris flows and avalanches may result. Water-ice interaction is very important and has been invoked to explain rates of erosion one to two orders of magnitude higher than previously assumed.
22. Mass wasting is a highly effective transport mechanism both for contributing to glacial sediment load and modifying landforms, but it is only effective for the former where steep and rugged terrain exists. It is therefore irrelevant to ice sheets or continental glaciers, which would thus tend to be starved for sediment.
23. Seasonal freezing and thawing promotes incorporation of sediment from the glacier bed in conjunction with ice thrusting and overpressured subglacial water. These conditions are most likely in glaciers with relatively steep gradients or conditions conducive to jökulhlaup generation.
24. Release of sediment into the proglacial area tends to be highly episodic due to changes in the ice margin relative to moraines.
25. Multiple directions in paleocurrent (ice flow) indicators do not imply a hiatus or multiple glaciations.
26. Glaciomarine effects of the Little Ice Age were much less than inferred for the Great Ice Age due to the much smaller ice extent during the former (particular at coasts) and the likely lower sea level during the Great Ice Age.
27. Many features resulting from the Little Ice Age are equifinal or polygenetic, many glacial landforms are relatively short lived, and inferences regarding the historically undocumented past must therefore be guarded and contingent.
28. Glaciation results in much glaciofluvial activity, from catastrophic jökulhlaups to "ordinary" glacial and proglacial streams. Lack of vegetation, as is common in glaciated areas, combined with heavy rainfall can produce very high sediment loading in streams. However, evidence exists for floods of regional extent in the past, far greater than the largest historically documented glacial outburst floods. Establishment thinking often opposes these catastrophes, but even they pale before the unique event described in Genesis 8–11. Much geologic work traditionally attributed to glaciation may be glaciofluvial or diluvial, and diluvialists need to explore these possibilities when speculating about the natural history of the features we observe today.

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Glossary

Bergschrund – the arcuate scarp at the headwall of a glacier; this is where headward erosion occurs, advancing the glacier into the mountain.

Deluge – a common deluge is intense rainfall (and flooding) over a short period of time. When capitalized, it refers to what the Bible calls the *mabbul*, the global flood of Noah's time.

Diamict – unconsolidated sediment consisting of a wide range of particle sizes in a fine-grained matrix. *Glacial till* is a genetic term for some diamicts and how they formed.

Diluvial – pertaining to the Deluge.

Diluvialist – one who believes most geologic work occurred during the Deluge.

Drumlin – a streamlined hill or ridge oriented parallel to fluid (e.g., ice) movement—a giant flute. Drumlins can be erosional or depositional.

Esker - a sinuous ridge, typically of gravel deposited by an englacial stream.

Geologic work – erosion (physical weathering and transport) and deposition, tectonic displacements, and other physical alteration of rocks and soils.

Jökulhlaup – a catastrophic glacial outburst flood caused when pent-up water is released during a volcanic eruption or when an ice dam floats due to the head of water.

Kame – melting of ice can produce a hill or mound where sediment had been dumped into a hole in the ice; such a hill or mound is a kame.

Kettle – a relatively small, deep hole formed when a large block of ice buried with sediment melts.

Moraine – a ridge formed by deposition of sediment from a glacier.

Sandur – a glacial outwash plain; an Icelandic term for the low gradient, coastal plains built by braided streams and jökulhlaups.

References

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Andrzejewski, L., and P. Molewski. 2007. Changes in the range of the snout of the Tungnaárjökull after the Little Ice Age relief and deposit recordings. *Proceedings of 37th International Arctic Workshop*. University of Iceland, Reykjavík, Iceland.

Anonymous. 2012. Historic photographs provide evidence on Greenland glaciers. *Bulletin of the American Meteorological Society* 93:1313–1314.

Ballantyne, C.K., and J.A. Matthews. 1982. The development of sorted circles on recently deglaciated terrain, Jotunheimen, Norway. *Arctic and Alpine Research* 14:341–354.

Benediktsson, Í.Ö., Ó. Ingólfsson, P. Möller, J.J.M. Van der Meer, K.H. Kjær, and J. Krüger. 2007. A one-day end moraine? Evidence from the surge-type Brúarjökull, Iceland. *Proceedings of 37th International Arctic Workshop*. University of Iceland, Reykjavík, Iceland.

Berthault, G. 1994. Experiments on stratification. In Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism*, technical symposium sessions, pp. 103–110. Creation Science Fellowship, Pittsburgh, PA.

Björnsson, H. 1980. Glaciers in Iceland. In Comité National Français de Géologie, *Geology of the European countries: Denmark, Finland, Iceland, Norway, Sweden*, pp. 136–157. Graham and Trotman, London, UK.

Boulton, G.S. 1970. On the origins and transport of englacial debris in Svalbard glaciers. *Journal of Glaciology* 9:213–229.

Boulton, G.S. 1986. Push moraines and glacier contact fans in marine and terrestrial environments. *Sedimentology* 33:677–698. Cited in Evans and Twigg, 2002.

Brynjólfsson, S. 2004. Rof- og setmyndanir við Sólheimajökul [in Icelandic]. Posted on Íngolfsson, 2008.

Burki, V., L. Hansen, O. Fredin, T.A. Andersen, A.A. Beylich, M. Jaboyedoff, E. Larsen, and J.-F. Tønnesen. 2010. Little Ice Age advance and retreat sediment budgets for an outlet glacier in western Norway. *Boreas* 39:551–566.

Carr, S.J., and M.A. Goddard. 2007. Role of particle size in till-fabric characteristics: systematic variation in till fabric from Vestari-Hagafellsjökull, Iceland. *Boreas* 36:371–385.

Connor, C., G. Streveler, A. Post, D. Monteith, and W. Howell. 2009. The Neoglacial landscape and human history of Glacier Bay, Glacier Bay National Park and Preserve, southeast Alaska, USA. *The Holocene* 19:381–393.

Cowton, T., P. Nienow, I. Bartholomew, A. Sole, and D. Mair. 2012. Rapid erosion beneath the Greenland ice sheet. *Geology* 40:343–346.

Croot, D.G. 1988. Morphological, structural and mechanical analysis of neoglacial ice pushed ridges in Iceland. In Croot, D.G. (editor), *Glaciotectonic Forms and Processes*, pp.49–61. Balkema, Rotterdam, Netherlands. Cited in Evans and Twigg, 2002.

Decaulne, A., E. Roussel, and M. Chenet. 2007. Post Little Ice Age changes in the Morsárjökull and Skaftafellsjökull proglacial landscape (Southeast of Iceland). *Proceedings of 37th International Arctic Workshop*. University of Iceland, Reykjavík, Iceland.

Dowdeswell, J.A., and M.J. Sharp. 1986. Characterization of pebble fabrics in modern terrestrial glacigenic sediments. *Sedimentology* 33:699–710.

Dugmore, A., and P. Buckland. 1991. Tephrochronology and late Holocene soil erosion in south Iceland. In Maizels, J.K., and C. Caseldine (editors), *Environmental Change in Iceland: Past and Present*, pp. 147–160. Kluwer Academic Publishers, Boston, MA.

Dunning, S.A., A.R.G. Large, A.J. Russell, J.J. Roberts, R. Duller, J. Woodward, A.-S. Mériaux, F.S. Tweed, and M. Lim. 2013. The role of multiple glacier outburst floods in proglacial landscape evolution: the 2010 Eyjafjallajökull eruption, Iceland. *Geology* 41:1123–1126.

Evans, D.J.A., and D.R. Twigg. 2002. The active temperate glacial landsystem: a model based on Breiðamerkurjökull and Fjallsjökull, Iceland. *Quaternary Science Reviews* 21:2143–2177.

Evans, S.G., O.V. Tutubalina, V.N. Drobyshev, S.S. Chernomorets, S. McDougall, D.A. Petrakov, and O. Hungr. 2009. Catastrophic detachment and high-velocity long-runout flow of Kolka Glacier, Caucasus Mountains, Russia in 2002. *Geomorphology* 105:314–321.

Feuillet, T., and D. Mercier. 2012. Post-Little Ice Age patterned ground development on two Pyrenean proglacial areas: from deglaciation to periglaciation. *Geografiska Annaler* 94:363–376.

Follestad, B.A., and O. Fredin. 2007. Late Weichselian ice flow evolution in south-central Norway. *Norwegian Journal of Geology* 87:281–289.

Gerrard, J. 1991. An assessment of some of the factors involved in recent landscape change in Iceland. In Maizels, J.K., and C. Caseldine (editors), *Environmental Change in Iceland: Past and Present*, pp. 237–254. Kluwer Academic Publishers, Boston, MA.

Grove, J.M. 1988. *The Little Ice Age*. Metheun & Co., Ltd., New York, NY.

Grove, A.T. 2001. The "Little Ice Age" and its geomorphological consequences in Mediterranean Europe. In Ogilvie, A.E.J., and T. Jónsson (editors), *The Iceberg in the Mist: Northern Research in Pursuit of a "Little Ice Age,"* pp. 121–136. Kluwer Academic Publishers, Boston, MA.

Haberle, T. 1991. Holocene glacial history of the Hörgárdalur area, Tröllaskagi, northern Iceland. In Maizels, J.K., and C. Caseldine (editors), *Environmental Change in Iceland: Past and Present*, pp. 147–160. Kluwer Academic Publishers, Boston, MA.

Hambrey, M.J., and N.F. Glasser. 2003. The role of folding and foliation development in the genesis of medial moraines: examples from Svalbard glaciers. *The Journal of Geology* 111:471–485.

Haugland, J.E. 2006. Short-term periglacial processes, vegetation succession, and soil development within sorted patterned ground: Jotunheimen, Norway. *Arctic, Antarctic, and Alpine Research* 38:82–89.

Hughes, A.L.C., E. Rainsley, T. Murray, C.J. Fogwill, C. Schnabel, and S. Xu. 2012. Rapid response of Helheim Glacier, southeast Greenland, to early Holocene climate warming. *Geology* 40:427–430.

Humlum, O. 1998. The climatic significance of rock glaciers. *Permafrost and Periglacial Processes* 9:375–395.

Humlum, O. 2000. The geomorphic significance of rock glaciers: estimates of rock glacier debris volumes and headwall recession rates in West Greenland. *Geomorphology* 35:41–67.

Íngolfsson, Ó. 2008. Ó Íngolfsson. https://notendur.hi.is/oi/index.htm (accessed February 3, 2015).

Iverson, N.R., D. Cohen, T.S. Hooyer, U.H. Fischer, M. Jackson, P.L. Moore, G. Lappegard, and J. Kohler. 2003. Effects of basal debris on glacier flow. *Science* 301:81–84.

Ives, J.D. 2007. *Skaftafell in Iceland: A Thousand Years of Change*. Ormstunga, Reykjavík, Iceland.

Johnson, M.D., A. Schomacker, Í.Ö. Benediktsson, A.J. Geiger, A. Ferguson, and Ó. Ingólfsson. 2010. Active drumlin field revealed at the margin of Múlajökull, Iceland: a surge-type glacier. *Geology* 38:943–946.

Kellerer-Pirklbauer, A., H. Slupetzky, and M. Avian. 2012. Ice-avalanche impact landforms: the event in 2003 at the glacier Nördliches Bockkarkees, Hohe Tauern Range, Austria. *Geografiska Annaler* 94:97–115.

Kjær, K.H., and J. Krüger. 2001. The final phase of dead-ice moraine development: processes and sediment architecture, Kötlujökull, Iceland. *Sedimentology* 48:935–952.

Kjær, K.H., E. Larsen, J. Van der Meer, Ó. Ingólfsson, J. Krüger, Í.Ö. Benediktsson, C.G. Knudsen, and A. Schomacker. 2006. Subglacial decoupling at the sediment/bedrock interface: a new mechanism for rapid flowing ice. *Quaternary Science Reviews* 25:2704–2712.

Klevberg, P., and M. Oard, 1998. Paleohydrology of the Cypress Hills Formation and Flaxville Gravel. In Walsh, R.E. (editor), *Proceedings of the Fourth International Conference on Creationism*, technical symposium sessions, pp. 361–378. Creation Science Fellowship, Pittsburgh, PA.

Klevberg, P., and M.J. Oard. 2005. Drifting interpretations of the Kennedy gravel. *CRSQ* 41:289–315.

Klevberg, P., and M.J. Oard. 2011a. The Little Ice Age in the North Atlantic region–part I: introduction to paleoclimatology. *CRSQ* 47:213–227.

Klevberg, P., and M.J. Oard. 2011b. The Little Ice Age in the North Atlantic region–part II: magnitude, extent, and importance of the Little Ice Age. *CRSQ* 48:49–58.

Klevberg, P., and M.J. Oard. 2012a. The Little Ice Age in the North Atlantic region–part III: Iceland. *CRSQ* 48:224–238.

Klevberg, P., and M.J. Oard. 2012b. The Little Ice Age in the North Atlantic region–part IV: Norway. *CRSQ* 49:43–55.

Klevberg, P., and M.J. Oard. 2014a. The Little Ice Age in the North Atlantic region–part V: Greenland. *CRSQ* 50:172–190.

Klevberg, P., and M.J. Oard. 2014b. The Little Ice Age in the North Atlantic region–part VI: Climatology. *CRSQ* 50:252–269.

Klevberg, P., and M.J. Oard. 2014c. The Little Ice Age in the North Atlantic region–part VII: constraints on the Great Ice Age. *CRSQ* 51:40–51.

Knight, P.G., C.E. Jennings, R.I. Waller, and Z.P. Robinson. 2007. Changes in ice-margin processes and sediment routing during ice-sheet advance across a marginal moraine. *Geografiska Annaler* 89:203–215.

Krabill, W., E. Frederick, S. Manizade, C. Martin, J. Sonntag, R. Swift, R. Thomas, W. Wright, and J. Yungel. 1999. Rapid thinning of parts of the southern Greenland ice sheet. *Science* 283:1522–1524.

Krüger, J. 1985. Formation of a push moraine at the margin of Höfdabrekkujökull, South Iceland. *Geografiska Annaler* 67A:199–212.

Krüger, J. 1993. Moraine-ridge formation along a stationary ice front in Iceland. *Boreas* 22:101–109.

Krüger, J. 1995. Origin, chronology and climatological significance of annual-moraine ridges at Myrdalsjökull, Iceland. *The Holocene* 5:420–427.

Krüger, J. 1996. Moraine ridges formed from subglacial frozen-on sediment slabs and their differentiation from push moraines. *Boreas* 25:57–63.

Landnåmsboken [record of Landnám AD 870–930]. 1997. Translated into Norwegian by L. Kjørsvik Schei. Aaschehoug, Oslo, Norway.

Larsen, E., and J. Mangerud, 1992. Subglacially formed clastic dikes. *Sveriges Geologiske Undersökning* Ser.Ca. 81:163–170.

Lawler, D. 1991. Sediment and solute yield from the Jökullsá á Solheimasandi glacierized river basin, southern Iceland. In Maizels, J.K., and C. Caseldine (editors), *Environmental Change in Iceland: Past and Present*, pp. 303–332. Kluwer Academic Publishers, Boston, MA.

Lukas, S. 2012. Processes of annual moraine formation at a temperate alpine valley glacier: insights into glacier dynamics and climatic controls. *Boreas* 41:463–480.

Maizels, J.K. 1991. The origin and evolution of Holocene sandur deposits in areas of jökulhlaup drainage, Iceland. In Maizels, J.K., and C. Caseldine (editors), *Environmental Change in Iceland: Past and Present*, pp. 267–302. Kluwer Academic Publishers, Boston, MA.

Martin, H.E., W.B. Whalley, and C. Caseldine. 1991. Glacier fluctuations and rock glaciers in Tröllaskagi, northern Iceland, with special reference to 1946–1986. In Maizels, J.K., and C. Caseldine (editors), *Environmental Change in Iceland: Past and Present*, pp. 255–266. Kluwer Academic Publishers, Boston, MA.

Matthews, J.A., and R.A. Shakesby. 2004. A twentieth-century neoparaglacial rock topple on a glacier foreland, Ötztal Alps, Austria. *The Holocene* 14:454–458.

Mattingsdal, R., K. Andreassen, and J.S. Laberg. 2007. Low-frequency 3D seismic data reveal detailed high-resolution images of glacial geomorphic features. *Proceedings of 37th International Arctic Workshop*. University of Iceland, Reykjavík, Iceland.

McKinzey, K.M., J.F. Orwin, and T. Bradwell. 2005. A revised chronology of key Vatnajökull (Iceland) outlet glaciers during the Little Ice Age. *Annals of Glaciology* 42:171–179.

Molén, M. 1990. Diamictites: ice-ages or gravity flows? In Walsh, R.E., and C.L. Brooks (editors), *Proceedings of the Second International Conference on Creationism*, technical symposium sessions and additional topics, pp. 177–190. Creation Science Fellowship, Pittsburgh, PA.

Molén, M. 2008. The Ice Age–it really was short. In Snelling, A.A. (editor), *Proceedings of the Sixth International Conference on Creationism*, technical symposium sessions, pp. 339–355. Creation Science Fellowship and Institute for Creation Research, Pittsburgh, PA and Dallas, TX.

Molewski, P., J.B. Szmanda, and L. Andrzejewski. 2007. Sedimentology of kame terrace deposits in the northwest side of the Tungnaárjökull forefield and its palaeogeomorphological interpretation. *Proceedings of 37th International Arctic Workshop*. University of Iceland, Reykjavík, Iceland.

Naylor, S., and E.J. Gabet. 2007. Valley asymmetry and glacial versus nonglacial erosion in the Bitterroot Range, Montana, USA. *Geology* 35:375–378.

Nussbaumer, S.U., A. Nesje, and H.J. Zumbühl. 2011. Historical glacier fluctuations of Jostedalsbreen and Folgefonna (southern Norway) reassessed by new pictorial and written evidence. *The Holocene* 21:455–471.

Oard, M.J., 1990. *An Ice Age Caused by the Genesis Flood*. Institute for Creation Research, Dallas, TX.

Oard, M.J. 1997. *Ancient Ice Ages or Gigantic Submarine Landslides?* Creation Research Society Monograph No. 6, Chino Valley, AZ.

Oard, M.J. 2004. *The Missoula Flood Controversy and the Genesis Flood*. Creation Research Society Books, Chino Valley, AZ.

Oard, M.J. 2009. Do varves contradict biblical history? In Oard, M.J., and J.K. Reed (editors), *Rock Solid Answers: The Biblical Truth behind 14 Geological Questions*, pp. 125–148. Master Books and Creation Research Society Books, Green Forest, AR and Chino Valley, AZ.

Owen, G., J.A. Matthews, and P.G. Albert. 2007. Rates of Holocene chemical weathering, 'Little Ice Age' glacial erosion and implications for Schmidt-hammer dating at a glacier-foreland boundary, Fåbergstølsbreen, southern Norway. *The Holocene* 17:829–834.

Owen, G., J.F. Hiemstra, J.A. Metthews, and L.J. McEwen. 2010. Landslide-glacier interaction in a neoparaglacial setting at Tverrbytnede, Jotunheimen, southern Norway. *Geografiska Annaler* 92:421–436.

Pálsson, H. 2000. *Nøkkel til islendingesagane* [in Norwegian]. Cappelen Akademisk Forlag, Oslo, Norway.

Porter, P.R., G. Vatne, F. Ng, and T.D.L. Irvine-Fynn. 2010. Ice-marginal sediment delivery to the surface of a high-Arctic glacier: Austre Brøggerbreen, Svalbard. *Geografiska Annaler* 92:437–449.

Price, R.J. 1969. Moraines, sandar, kames and eskers near Breidamerkurjökull, Iceland. *Transactions of the Institute for British Geography* 46:17–43.

Price, R.J. 1971. The development and destruction of a sandur, Breidamerkurjökull, Iceland. *Arctic and Alpine Research* 3:225–237.

Price, R.J. 1982. Changes in the proglacial area of Breiðamerkurjökull, southeastern Iceland: 1890–1980. *Jökull* 32:29–35.

Price, R.J., and P.J. Howarth. 1970. The evolution of the drainage system (1904–1965) in front of Breidamerkurjökull, Iceland. *Jökull* 20:27–37.

Reed, J.K. 1999. Historiography and natural history. *CRSQ* 37:160–175.

Reed, J.K., and P. Klevberg. 2014a. Beyond "origin & operation" science, part I: critique of OS². *CRSQ* 50:237–251.

Reed, J.K., and P. Klevberg. 2014b. Beyond "origin & operation" science, part II: an alternative. *CRSQ* 51:31–39.

Reinardy, B.T.I., I. Leighton, and P.J. Marx. 2013. Glacier thermal regime linked to processes of annual moraine formation at Midtdalsbreen, southern Norway. *Boreas* 42:896–911.

Roberts, D.H., and A.J. Long. 2005. Streamlined bedrock terrain and fast ice flow, Jakobshavns Isbrae, West Greenland: implications for ice stream and ice sheet dynamics. *Boreas* 34:25–42.

Rose, J., C.A. Whiteman, J. Lee, N.P. Branch, D.D. Harkness, and J. Walden. 1997. Mid- and late-Holocene vegetation, surface weathering and glaciation, Fjallsjökull, southeast Iceland. *The Holocene* 7:457–471.

Rushmer, E.L. 2006. Sedimentological and geomorphological impacts of the jökulhlaup (glacial outburst flood) in January 2002 at Kverkfjöll, Northern Iceland. *Geografiska Annaler* 88:43–53.

Russell, A., M. Burke, J. Woodward, P. Fleisher, A. Gregory, P. Bailey, D. Blauvelt, and A. Large. 2007. The morphology and sedimentology of a jökulhlaup esker, Skeiðarárjökull, Iceland. *Proceedings of 37th International Arctic Workshop*. University of Iceland, Reykjavík, Iceland.

Sanders, J.W., K.M. Cuffey, J.R. Moore, K.R. MacGregor, and J.L. Kavanaugh. 2012. Periglacial weathering and headwall erosion in cirque glacier bergschrunds. *Geology* 40:779–782.

Schiefer, E., B. Menounos, and O. Slaymaker. 2006. Extreme sediment delivery events recorded in the contemporary sediment record of a montane lake, southern Coast Mountains, British Columbia. *Canadian Journal of Earth Sciences* 43:1777–1790.

Shaw, J., and D.R. Sharpe. 1987. Drumlin formation by subglacial meltwater erosion. *Canadian Journal of Earth Sciences* 24:2316–2322.

Shaw, J., B. Rains, R. Eyton, and L. Weissling. 1996. Laurentide subglacial outburst floods: landform evidence from digital elevation models. *Canadian Journal of Earth Sciences* 33:1154–1168.

Shoemaker, E.M. 1995. On the meltwater genesis of drumlins. *Boreas* 24:3–10.

Símonarson, Leifur A. 1980. On climate changes in Iceland. In Comité National Français de Géologie, *Geology of the European countries: Denmark, Finland, Iceland, Norway, Sweden*, pp. 136–157. Graham and Trotman, London, UK.

Smith, L.C., D.E. Alsdorf, F.J. Magilligan, B. Gomez, L.A.K. Mertes, N.D. Smith, and J.B. Garvin. 2000. Estimation of erosion, deposition, and net volumetric change casused by the 1996 Skeiðarársandur jökulhlaup, Iceland, from synthetic aperture radar interferometry. *Water Resources Research* 36:1583–1594.

Syverson, K.M., and D.M. Mickelson. 2008. Origin and significance of lateral meltwater channels formed along temperate glacier margin, Glacier Bay, Alaska. *Boreas* 38:132–145.

Szmanda, J.B., P. Molewski, M. Luc, and L. Andrzejewski. 2007. Formation of the glacial and glaciofluvial relief, case study—middle part of the Tungnaárjökull marginal zone. *Proceedings of 37th International Arctic Workshop*. University of Iceland, Reykjavík, Iceland.

Thompson, A., and A. Jones, 1986. Rates and causes of proglacial river terrace formation in southeast Iceland: an application of lichenometric dating techniques. *Boreas* 15:231–246.

Waller, R.I., A.J. Russell, T.A.G.P. Van Dijk, and Ó. Knudsen. 2001. Jökulhlaup-related ice fracture and supraglacial water release during the November 1996 jökulhlaup, Skeiðarárjökull, Iceland. *Geografiska Annaler* 83:29–38.

Yde, J.C., and N.T. Knudsen. 2005. Glacilogical features in the initial quiescent phase of Kuannersuit Glacier, Greenland. *Geografiska Annaler* 87:473–485.

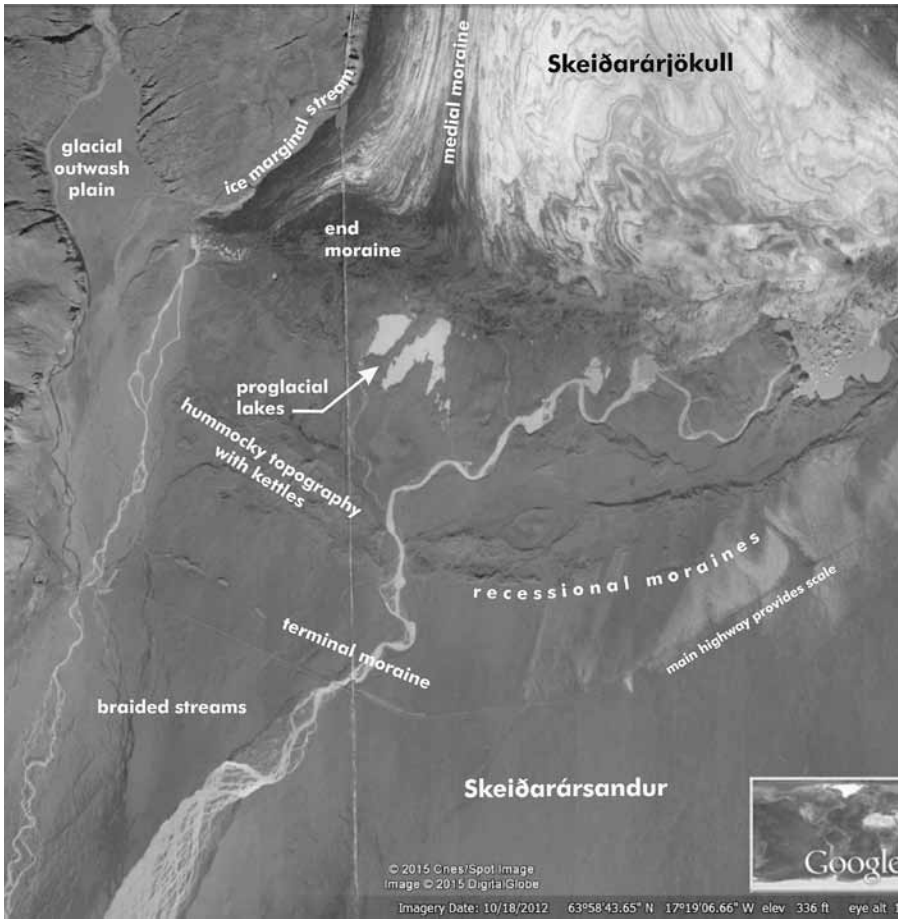


Figure A1. Aerial photomosaic of snout of Skeiðarárjökull with glacial landforms labeled. Meltwater channels have shifted frequently through the years.

Appendix A: Illustrations of Glacial Landforms

As documented in Part III of this series (Klevberg and Oard, 2012a), southeastern Iceland provides some of the best-documented glacial features from the Little Ice Age. Figures A1–A6 are all from the Vatnajökull area.

While water is the most common fluid for transporting sediment, ice is the most viscous. Large quantities of rock and debris sometimes avalanche onto glaciers from oversteepened valley walls, and the ice slowly carries its large sediment burden down the valley. Outlet glaciers drain large inland bodies of ice

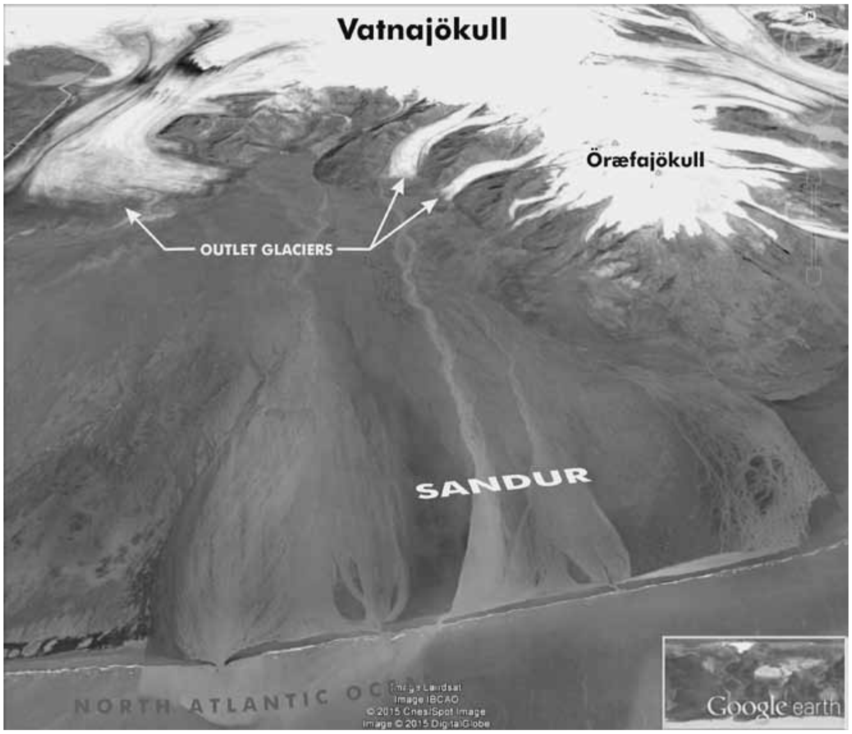
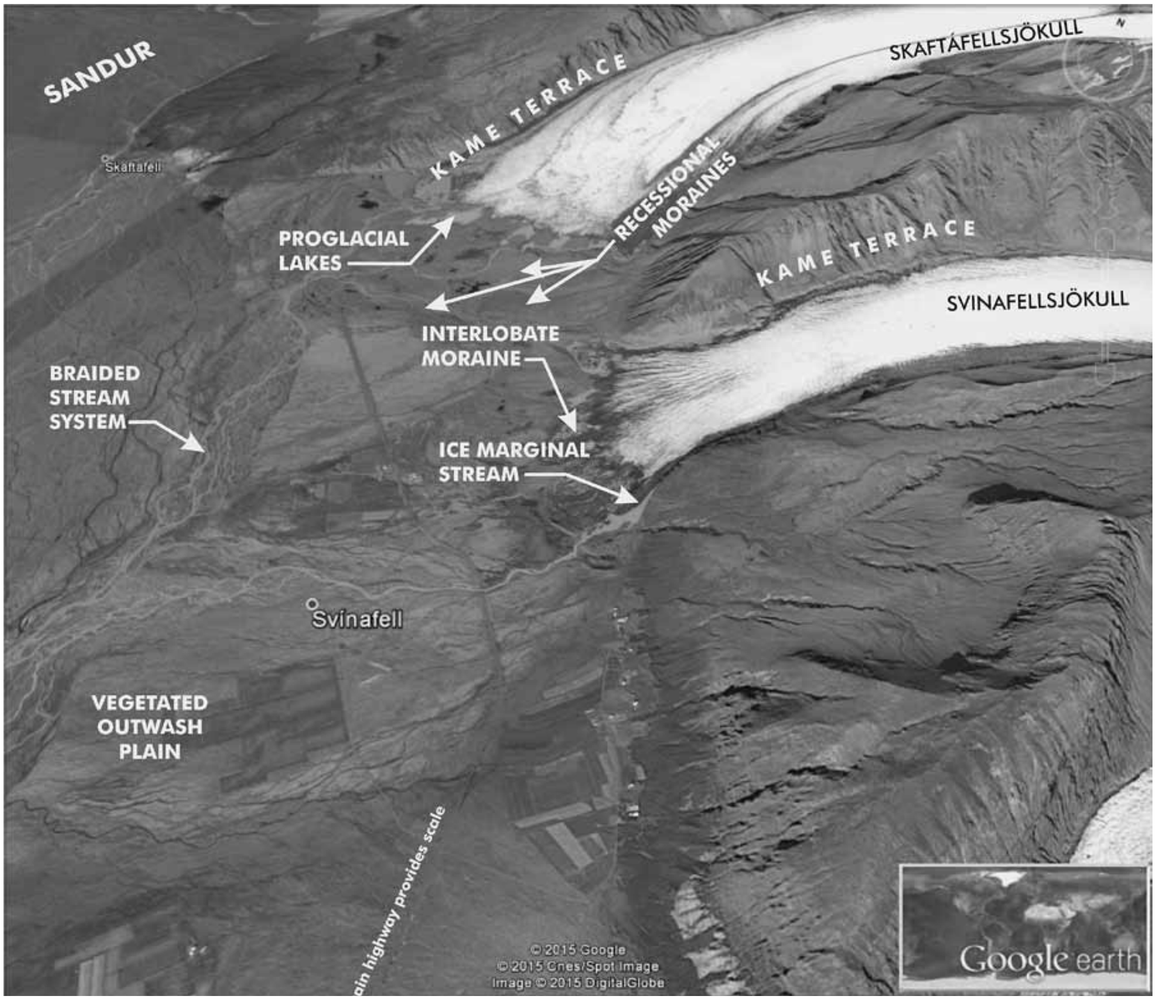


Figure A2 *(left)*. Prominent sandur south of Vatnajökull. The outlet glacier to the left (west) is Skeiðarárjökull; the two indicated to the right (east) are Skaftafelljökull and Svinafelljökull. Oblique Google Earth view.

Figure A3 *(below)*. A closer view of the area shown in Figure A2, showing various glacial landforms produced by Skaftafelljökull and Svinafelljökull, mostly during the Little Ice Age.



such as Vatnajökull in Iceland (Figure 2) and the Greenland Ice Sheet (Figure 1). Debris stuck in the ice scratches bedrock, forming *striations*, as well as rounding and polishing the bedrock. As the ice melts, it dumps its load, often quite quickly. This typically results in an unsorted mixture of all different sediment sizes known as *till*. The till forms *moraines*, sometimes shaped as ridges along the middle, edges, or snout of glaciers. Till is also pushed by moving ice and deposited from the ice as it melts and recedes. It may be shaped by flowing ice into *flutes* and *drumlins*.

Much of the glacial landscape is actually formed by running water. Melting ice provides a source of water that flows as englacial streams, subglacial and supraglacial streams, marginal streams, and braided streams. Where water is stored up beneath or behind a glacier and then bursts forth suddenly in a *jökulhlaup*, enormous amounts of geologic work can be done in a very short period of time. Jökulhlaups are primarily responsible for the large *sandar* of Iceland.

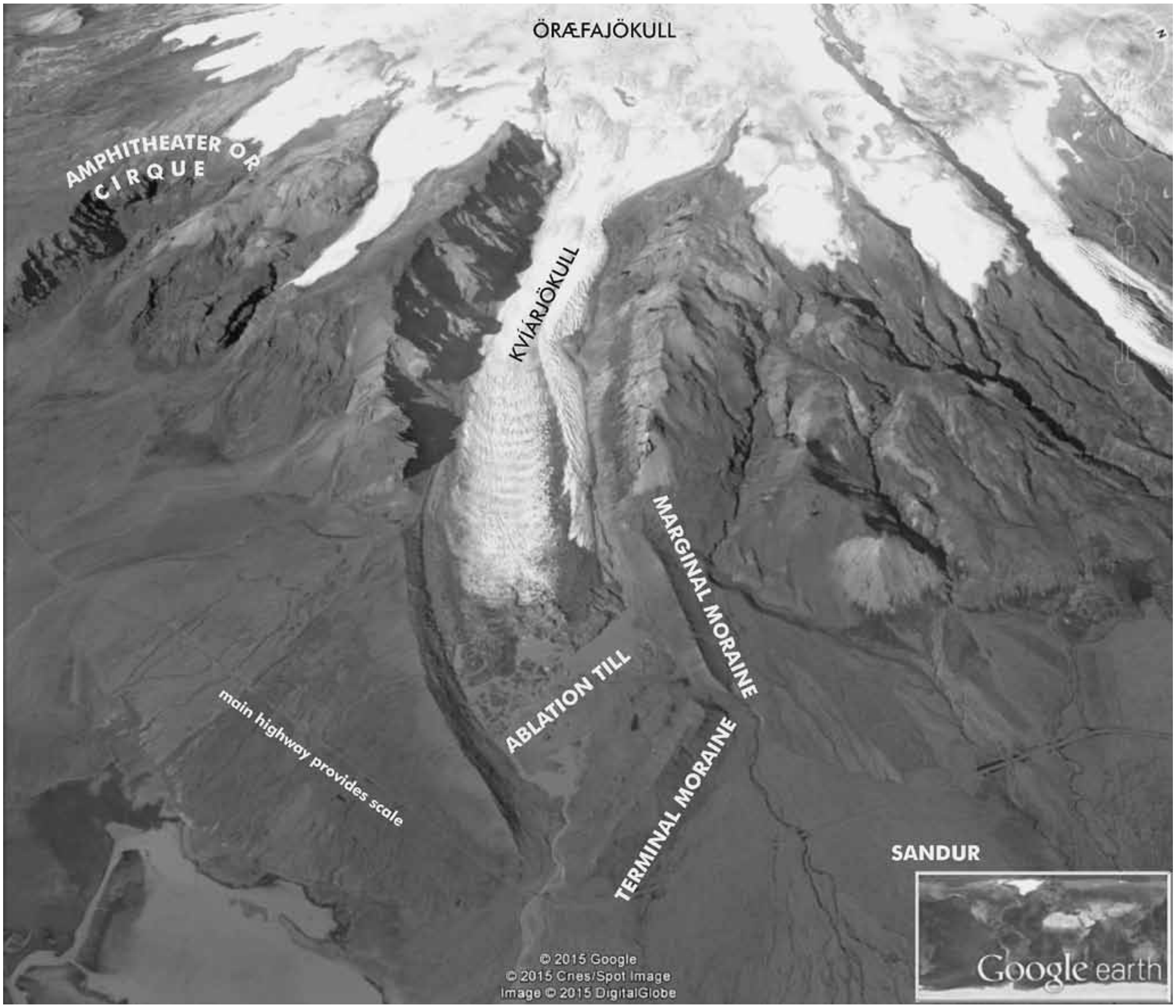


Figure A4. Öræfajökull is the ice cap on Öræfi, the high mountain at the south end of Vatnajökull. Kvíárjökull is the most prominent outlet glacier from Öræfajökull and occupies a deeply cut valley. The terminal moraine arrested the advance of the glacier during the Little Ice Age (Ives, 2007). The other outlet glaciers tend to move less ice and produce less erosion as a result. The prominent erosional feature to the left (northwest) may be an an amphitheater produced by mass wasting, a cirque eroded by a glacier, or as seems likely, an amphitheater in which ice contributed to enlargement during the Little Ice Age. Oblique Google Earth view.

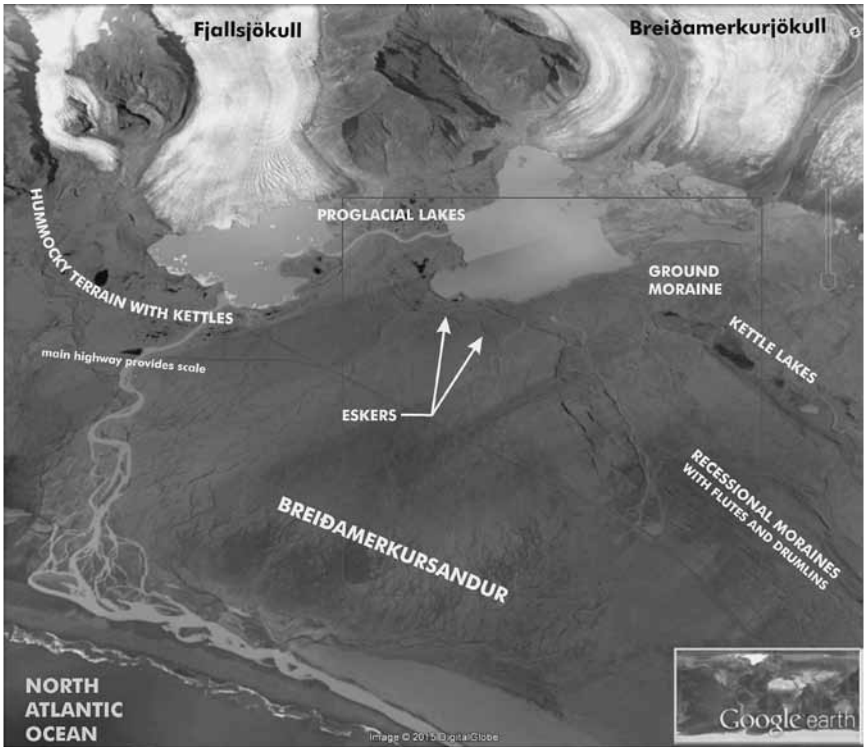
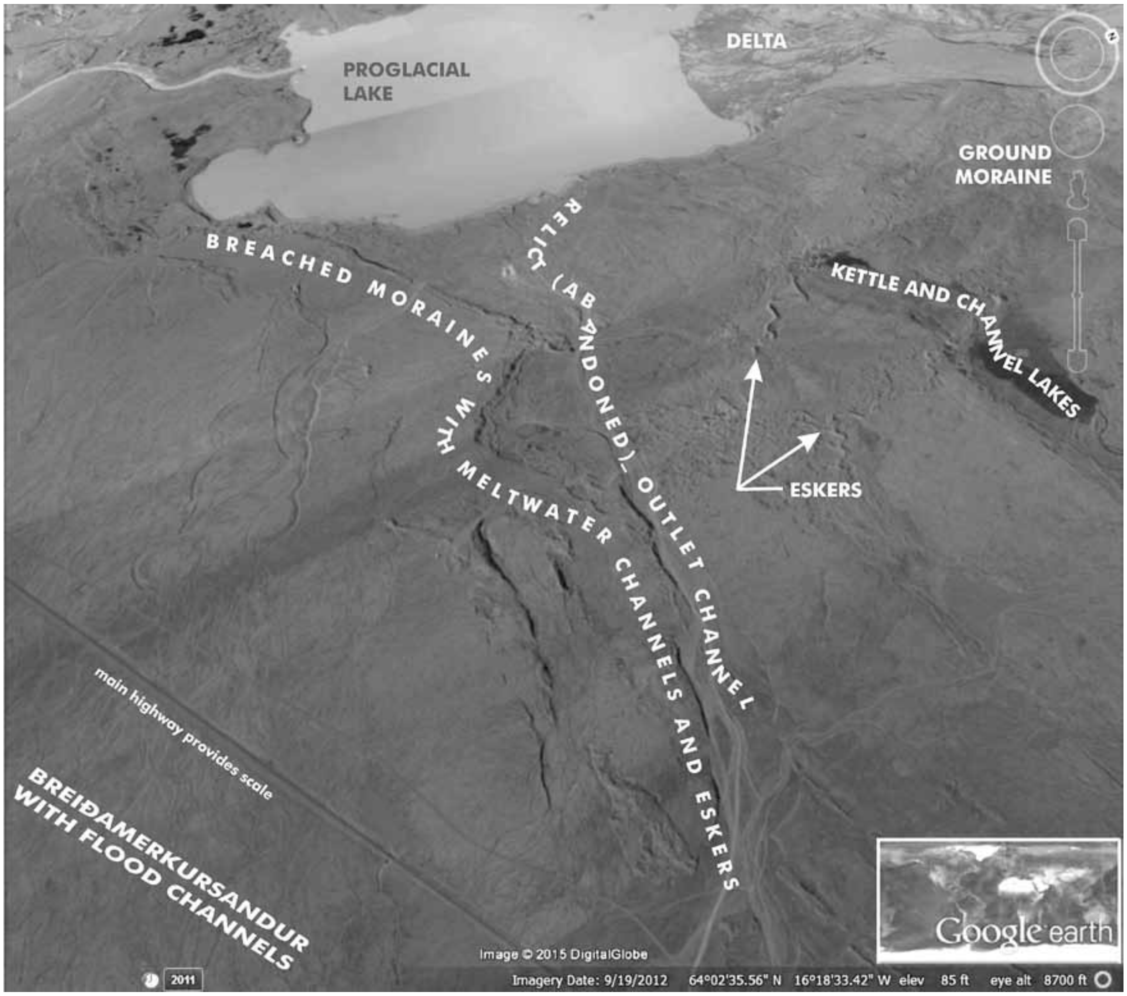


Figure A5 *(left)*. Oblique Google Earth image of Breiðamerkur southeast of Vatnajökull, Iceland, with glacial landforms indicated.

Figure A6 *(below)*. Closer view of part of area shown in Figure A5 with some glacial landforms labeled. This area was completely covered by advancing glaciers during the Little Ice Age (Klevberg and Oard, 2012a).


PROGLACIAL LAKE
DELTA
GROUND MORAINE
BREACHED MORAINES WITH MELTWATER CHANNELS AND ESKERS
RELICT (ABANDONED) OUTLET CHANNEL
KETTLE AND CHANNEL LAKES
ESKERS
main highway provides scale
BREIÐAMERKURSANDUR WITH FLOOD CHANNELS
Image © 2015 DigitalGlobe
2011
Imagery Date: 9/19/2012 64°02'35.56" N 16°18'33.42" W elev 85 ft eye alt 8700 ft
Google earth

Appendix B: Recommendations for Future Research

The work summarized in this series shows many possibilities for fruitful research. In particular, we recommend others consider researching the following:

- Evidence for and effects of the Little Ice Age in other regions
- The veracity of transfer functions and whether some proxy data may be used to provide independent rather than interdependent lines of evidence in paleoclimatology
- Evidence for or against the Medieval Warm Period and whether it was global or regional
- Global heat balance questions (insolation, volcanic effects, etc.)
- Nonglacial geologic processes that generate deposits and landforms that can also be generated glacially
- Additional fabric studies in known glacial and nonglacial environments and suspected glacial terranes, including clast roundness ratios
- Isostatic adjustments of Greenland during and after the Little Ice Age

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Understanding Open Questions on the Origin of Life

Peter M. Murphy*

Abstract

Open, unanswered questions in the field of origin of life (OoL) describe the vast gaps in explaining the supposed historical, continuous, and naturalistic path from lifeless chemicals to cellular life that utilizes genetics and metabolism. At three recent international conferences, participants clarified dozens of open questions on the origin of life (OQ/OoL) and discussed possible scientific and philosophical resolutions. This paper examines a few important OQ/OoL from the perspective that a naturalistic OoL scenario contradicts the revelation of creation in Scripture and that scientific research is bringing into focus how difficult it will be to resolve these OQ/OoL, rather than converging toward explanations for a naturalistic, historical explanation of the OoL.

Introduction

Over the past few years, international conferences were held to discuss open questions on the origin of life (OQ/OoL) in Sicily (EMFCSC, 2006), Spain (Astrobiology Workship, 2009), and Leicester, UK (University of Leicester, 2012). A similar meeting held at the Royal Society in 2006 also noted, "The ubiquity of open questions [on the emergence of life on the early earth]" (Jortner, 2006, p. 1885). While this author did not attend these conferences, papers, presentations, and reports from the conferences are well documented in the peer-reviewed literature and on websites for each conference. These conferences gave evolutionary scientists, educators, and philosophers the opportunity (1) to gauge the overall progress on origin of life (OoL) research, (2) to identify and clarify "big-picture" unanswered areas within the OoL field, and (3) to facilitate collaboration and cooperation between diverse research efforts. These conferences were held because, as Luisi and Ruiz-Mirazo summarized (2010, p. 353), "The origin of life on Earth is still a mystery, one of the greatest mysteries in science today. … Our ignorance about the origin of life is profound—not just some simple missing mechanistic detail." Dozens of significant OQ/OoL span the disciplines of (1) philosophy—what is life? (2) chemistry—how did the prebiotic syntheses of macromolecular proteins and nucleic acids occur? (3) biology—how did metabolism and genetics become unified? (4) physics—how did catalytic cycles overcome thermodynamic and kinetic constraints? (5) astronomy—where did life begin? and (6) geology—what were the conditions on the prebiotic earth?

One significant OQ/OoL is the origin of homochirality for biochemical polymers. The difficulties of finding a naturalistic origin of homochirality for amino acids and polypeptides were

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recently reviewed in this publication (Murphy, 2013). Emergence is another common theme in OQ/OoL, including (1) how does biochemistry and biology emerge from chemistry, and (2) is life an emergent property? OQ/OoL span both top-down and bottom-up research approaches. Top-down research methodologies look for evidence of progressively simpler ancestors of modern cellular life toward the first "living" creature, often called the last universal common ancestor (LUCA), or the cenancestor. Bottom-up research methodologies strive to understand how lifeless inorganic chemicals formed the biochemical polymers necessary for life and how those components self-organized into the first "living" creature.

The overwhelming majority of OoL scientific research and philosophy is based on naturalistic and materialistic assumptions. Their efforts seek to contradict God's creation *ex nihilo* described in Holy Scripture, including in Genesis, Exodus, John, Acts, Hebrews, and Colossians. OQ/OoL continue to accumulate because naturalistic OoL research yields scientific contradictions and dead-ends, as the work is based on false assumptions that exclude the Creator. In mathematics, an "indirect proof" establishes the truth of a proposition by showing that if the proposition is false a contradiction will result. In the fields of SETI (the Search for Extraterrestrial Intelligence), archeology, cryptography, and forensics, once all natural explanations for the observations and evidence are eliminated, some other explanation for the observations and evidence must be pursued. Similarly, OQ/OoL should continue to accumulate over time, and these questions will become more difficult to overcome due to their false foundation of creation apart from God and contrary to biblical revelation. One proposed open question for the 2009 OQOL conference even wondered why the field of OoL research "has not progressed much since the early experiments of Stanley Miller [in the 1950s]". Lahava et al. (2001, p. 77) concluded, "After almost 50 years of modern research, there is no paradigm of the origin of life." The lack of progress in naturalistic OoL research is a shocking admission, especially when compared to the staggering and impressive advancements in other scientific fields in the past six decades.

The Significance of the Conferences for Open Questions on the Origin of Life

Just like other scientific communities, OoL researchers use societies (e.g., ISSOL, the International Society for the Study of the Origin of Life), journals (e.g., *Origins of Life and Evolution of Biospheres*), and conferences to network, to collaborate, to publish, and to seek research funding. Recent conferences on OQ/OoL fostered much debate since these OQ/OoL do not have any single plausible explanation and invariably have competing theories with limited experimental data, scant observed evidence, and no scientific consensus to convincingly answer many of the particular aspects of the naturalistic approach to the OoL. Thus, OoL researchers are each other's harshest critics. Scientists challenge competitors' research and ideas by peer-review to reject and criticize unwarranted assumptions, poor experimental methodology or data analysis, and unjustified conclusions and to propose alternative interpretations. These conferences on OQ/OoL clarified the gaps in their collective scientific knowledge and challenged each other's unverified theories, speculations, assumptions, and explanations.

Pearcey and Thaxton (1994, p. 21ff) wrote that "modern science arose within a culture saturated with Christian faith," and that the philosophical underpinnings of science include that (1) nature is real, (2) nature is good and of great value, (3) nature is worthy of study, (4) nature is not God, (5) events in the natural world occur in a reliable and predictable fashion, often characterized as the "laws of nature," (6) the "laws of nature" can be stated in precise mathematical formulas, (7) the order in the natural world is intelligible and can be interpreted and understood by a rational mind, (8) the order in the natural world must be found by observation and experiment rather than rational deduction, and (9) the ordered, intelligible, good world reflects the character of the God of the Bible. Modern scientists will nearly universally accept 1 through 8, but to the extent that scientists believe in 9, materialistic, naturalistic science excludes any role for God in the past, present, or future in the physical world. In other words, belief in God is acceptable so long as no active role is assigned to God. Researchers studying the OQ/OoL seek explanations for how lifeless earth, water, air, and fire became today's extremely complex living creatures in a way that is consistent with the known natural, scientific laws of physics, chemistry, biology, geology, astronomy, thermodynamics, etc.

OoL researchers fabricate compelling narratives for life's origin and subsequent evolution, interweaving scientific explanations with optimism and enthusiasm for future discoveries to fill in the missing gaps in their OoL scenarios. Advocates for the biblical account of Creation in Genesis must enter into the debates on the OQ/OoL with caution. Like picking up a 7–10 split in bowling, if we merely knock down one of the multiple naturalistic explanations or theories for some aspect of an OQ/OoL, then other naturalistic explanations remain and perhaps are even strengthened. Since divine creation did not proceed through a long evolutionary history of intermediate chemical and biochemical transitions toward living creatures, all naturalistic explanations for the OoL will ultimately be proved untrue by the standard of being consistent with known scientific laws. We can often accept the criticism OoL researchers shower on one another without accepting the incomplete evidence they provide for their own particular naturalistic explanations for OoL scenarios. What follows is a brief description of a few of the OQ/OoL addressed at the conferences in 2006, 2009, and 2012 and their significance as a means to strengthen our faith in the biblical account of Creation.

OQ/OoL #1: Where Did Life Begin?

Hazen (2005) has pointed out that since the 1980s, the OoL field began to transform from the search for the "Origin of Life" (singular) to the search for the "Origins of Life" (plural). This change reflects the beliefs and hopes of OoL researchers that the appearance of life in the universe is frequent and that many individual origin events occurred and coordinated to produce living creatures on earth. This change may be motivated by the need to keep our planet Earth from being unique in any sense—for example, alone being just right for life. In the 1990s, NASA funding drove the search for life both to extreme environments on earth and throughout the universe, thus expanding OoL research from the disciplines of chemistry and biology to the fields of astrobiology, astronomy, and geology. Conducting scientific research is expensive, and the pursuit of research funding is highly competitive among research groups. Since funding drives scientific research, which results in publications that build reputations and careers, the scientific consensus about where life began perhaps became more influenced by self-interest than by evidence alone. For example, Witze (2013) reported on the alarm among planetary scientists with NASA's announcement of a restructuring of how NASA research is funded. Currently there is no evidence (observed or replicated in a laboratory) that life exists or has ever existed anywhere in the universe (except here on earth) in its current form or in any intermediate or transitional lifelike form.

The naturalistic search for a continuous OoL path from lifeless chemicals to living creatures spans many terrestrial and extraterrestrial environments looking for individual biochemical materials, organic precursors, fossils, primitive cellular life, and other evidence of life's origins. On earth, OoL researchers pose scenarios for formation on mineral surfaces, at hydrothermal vents, or in aqueous environments ranging in temperatures from above boiling to below freezing. At the 2012 Leicester conference, various presentors argued that each location has potential advantages and disadvantages regarding energy availability, chemical composition, reaction rates, and molecular stability. Astrobiology expanded the search for chemical compounds synthesized under prebiotic conditions to meteorites and the cosmos, seeking to explain the origin of abiotic organic and bio-organic compounds, and ultimately life on earth. Pascal (2012) claims that extraterrestrial OoL research benefits from a wider range of chemical compositions, temperatures, and energy sources (chemical, electromagnetic radiation, mechanical, geothermal) than were ever possibly present on earth. So far, no complex biochemical materials (e.g., oligopeptides or nucleotides) have been detected in any cosmic material. As stated in regard to the Sicily conference, "What we learn from cosmic products is of limited interest regarding macromolecular prebiotic molecular evolution" (EMFCSC, 2006).

A lack of scientific consensus on "where life began" means that none of the explanations offered by naturalistic OoL research is even remotely close to offering a scenario where lifeless chemicals were transformed to living, cellular creatures in a way that is consistent with the known laws of nature. A few key problems with terrestrial OoL include the availability of chemical materials and energy sources, the dilution problem, and the thermodynamic constraints of an aqueous environment. A few key problems with extraterrestrial OoL include the stability of biochemical materials in the harsh cosmic environment, transport of organic materials to earth, and contamination of any extraterrestrial sample analyzed on earth. Genesis describes the creation of the heavens, the earth, and all living creatures—that is everything—as resulting from the decree of God. The enthusiastic pursuit of the extraterrestrial search for the OoL testifies to the futility of finding a naturalistic explanation of the OoL exclusively here on earth. When those extraterrestrial efforts also prove unsuccessful, the only scientific conclusion will be that the underlying assumptions of any naturalistic OoL were "indirectly proven" to be false and that life was the result of the special creation of God.

OQ/OoL #2: Was the Origin of Life Heterotropic or Autotropic?

Heterotrophic organisms use available complex organic compounds for growth and energy since they cannot produce these materials for themselves. Autotrophic organisms are capable of synthesizing their own food from inorganic substances, using light or chemical sources of energy. Early naturalistic OoL research focused on various heterotrophic scenarios in which organic and biochemical compounds supposedly accumulated in a prebiotic world by diverse processes until some self-organization processes culminated in life's origin (see Figure 1). More recently, a variety of competing autotrophic OoL scenarios have been theorized in which simple chemical processes (e.g., inorganic, C_1, C_2) progressively organized themselves and evolved toward life (OQOL, 2009, pp. 391ff). As Mansy (2010, p. 394) summarized, "The heterotroph sup-

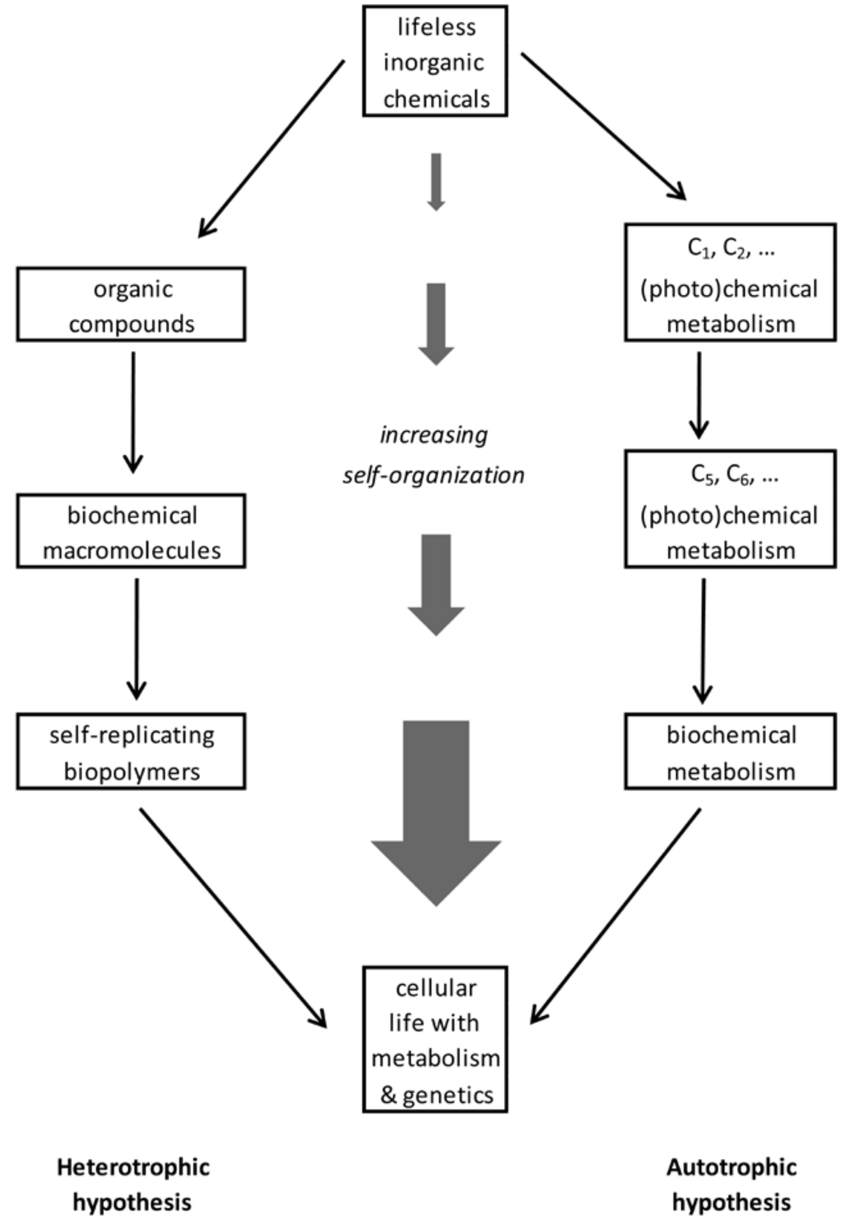

lifeless inorganic chemicals
organic compounds
biochemical macromolecules
self-replicating biopolymers
increasing self-organization
C₁, C₂, …
(photo)chemical metabolism
C₅, C₆, …
(photo)chemical metabolism
biochemical metabolism
cellular life with metabolism & genetics
Heterotrophic hypothesis
Autotrophic hypothesis

Figure 1. An overview of heterotrophic and autotrophic origin-of-life (OoL) pathways.

porters tend to focus on the creation of self-replicating systems dependent upon provided energy sources, and the autotrophic supporters often focus on geochemical cycles that mimic contemporary biochemical paths. In short, heterotrophy versus autotrophy emerges as replication-first versus metabolism-first arguments." Both the autotrophic and heterotrophic OoL approaches have large open questions concerning the vast difference in complexity between lifeless inorganic materials and living cellular organisms. Smith and Morwitz (2010, p. 398) concluded, "The problems for deciding between autotrophic and heterotrophic origins therefore come from uncertainty about mechanisms of organization."

Various naturalistic OoL scenarios lie along a continuum from heterotrophic to autotrophic. Ever since Oparin (1936) proposed a process for the evolution of life on earth, all naturalistic OoL schemes have lacked sufficient evidence to convincingly demonstrate a viable route from lifeless inorganic chemicals to cellular life. No one has found evidence of either autotrophic metabolic cycles or heterotrophic self-replicating biopolymers that would have served as intermediate or transitional stages in an OoL pathway toward cellular life. One common explanation for lack of evidence for the supposed steps from lifeless inorganic chemicals to cellular life is that any early OoL metabolic cycles or genetic replicators "ate the evidence" (Hazen, 2005, lesson 3). This incredible claim implies that once upon a time there was at least one continuous pathway from lifeless inorganic chemicals to cellular life that existed long enough for cellular life to become established, at which point the living creatures then consumed any and all evidence for any and all intermediates and transitional stages along the OoL path. This explanation is comparable to a bridge built between remote islands and after everyone finished traveling between the islands, all evidence of the bridge was removed, including any evidence that anyone ever knew how to build a bridge or had any other way to travel between these remote islands.

Autotrophic OoL schemes require somewhat simpler chemical environments and energy sources, but much more complex metabolic cycles to evolve toward self-replication. Pascal (2010, p. 393) noted, "Converting redox potentials into free energy available for a metabolism is a difficult task … the inorganic sources of energy [in a primitive earth environment] are not considered as able to deliver free energy in amounts … sufficient to induce biological self-organization." Smith and Morwitz (2010, p. 399) concluded, "We currently lack a principled, quantitative, chemically explicit theory of the requirements to stabilize a metabolic network and a self-generated control system far from thermodynamic equilibrium."

Heterotrophic OoL schemes postulate a somewhat simpler series of transitional OoL stages but require a much more complex environment in both quantity and variety of biochemical materials for progressive self-organization. As Zaia and Zaia (2008, p.1600) summarized, "The heterotrophic organisms need molecules (proteins, lipids, sugars, etc.) ready to be used as an energy source for other syntheses." Pereto (2005, pp.24–26) concluded:

> In this scenario, life would have started with very simple anoxygenic and heterotrophic primordial cells. Difficulties regarding prebiotic chemical reactions in the atmosphere (since we still lack any robust evidence of its … exact chemical composition and physical conditions) and uncertainties as to the accumulation of extraterrestrial organics have shifted the focus in search of other locations for primeval living processes.

Even if the open question of metabolism first or genetics first is ever resolved, OoL research would then face the significant open question summarized by Norris et al (2012, p. 487): "How did metabolism and genetic replication get married?" And this is not the only concerted merging of biochemical capabilities. The minimum essential characteristics of biological life include information (genetics), complexity, metabolism, growth, reproduction, irritability, and adaptation. Finding a means of self-replication of biopolymers, for example RNA or polypeptides, is only a miniscule first step toward the first hypothetical life-form.

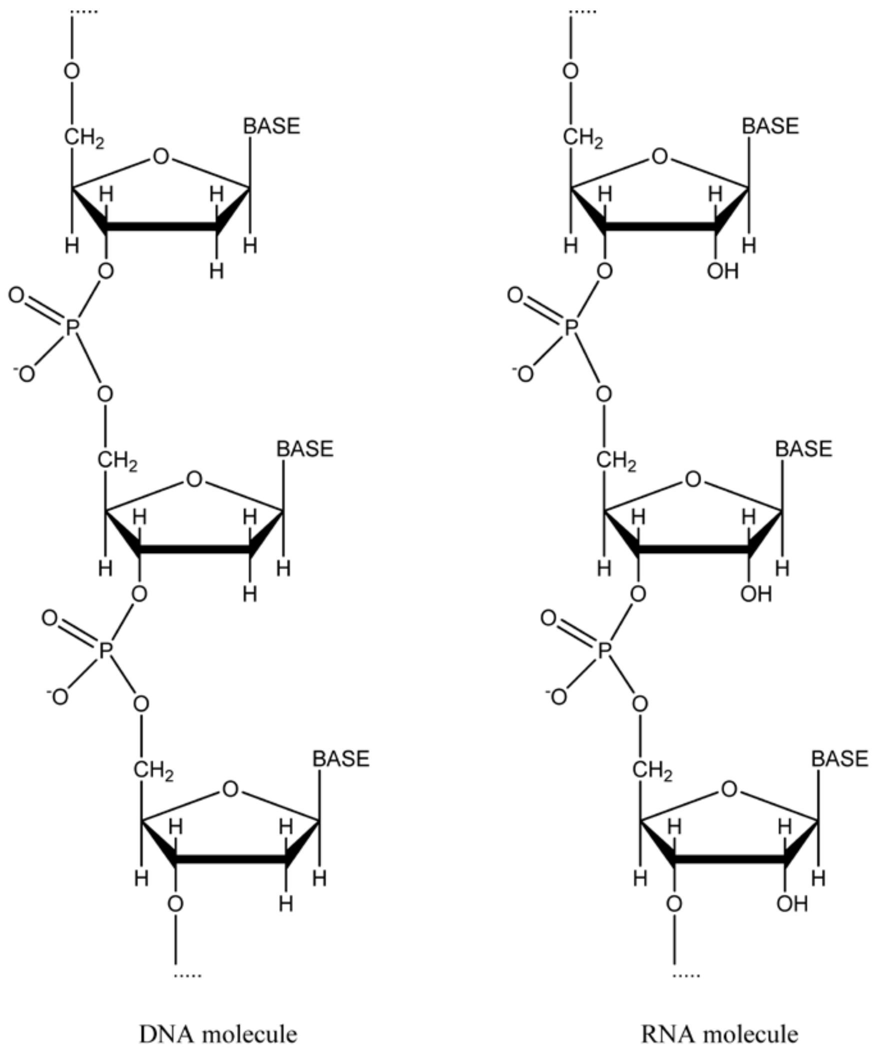
The bottom line is that no evidence exists to show that either the heterotrophic or autotrophic OoL processes are occurring today. Nor has evidence been found to suggest that any complete heterotrophic or autotrophic OoL scheme was operative in an early earth environment. Today, we see lifeless chemical compounds, and we see living cellular organisms, but we see nothing in between, such as any series of transitional stages or OoL pathways from mere chemicals to living creatures. OoL research continues to reveal the enormous gap between the composition and complexity of these two aspects of God's created order. The vast gap between lifeless chemicals and living creatures is wonderfully expressed in Genesis 2:7: "The Lord God formed a man from the dust of the ground and breathed into his nostrils the breath of life, and the man became a living being" (NIV).

OQ/OoL #3: How Plausible Is the "RNA World" Origin-of-Life Hypothesis?

Luisi and Ruiz-Mirazo (2010, p. 420) concluded that for many OoL researchers, "the origin of life on the basis of a prebiotic family of RNAs is the preferred scenario." Ribonucleic acid (RNA) is the leading single-biopolymer model proposed for OoL that may have preceded the current two-biopolymer system, which is based on deoxyribonucleic acid (DNA) and proteins. In all observed living creatures, DNA is the genetic biopolymer that stores information and directs the biosynthesis of proteins. Proteins provide a diversity of structure, metabolism, and catalysis necessary for life. Modern biology has found that RNA molecules exhibit a wide range of self-replication and catalytic properties, which leads OoL researchers to see vast possibilities and potential (Luis et al., 1999; Vaidya et al., 2012). While DNA does not catalyze its own reproduction, one drawback for RNA is its high susceptibility to hydrolysis (Voet and Voet, 2004).

RNA is an unbranched polymer consisting of ribose sugars precisely joined together by phosphate bonds, with each ribose containing one heterocyclic base. Note the differences between RNA and DNA in Figure 2. A monomer unit of RNA or DNA, which consists of a base, a sugar, and a phosphate, is a nucleotide. While RNA is chemically similar to DNA, there are some important differences. In DNA, the sugar is deoxyribose (no OH group in the 2 position of the ribose). Both DNA and RNA use four heterocyclic bases: three in common (guanine, adenine, and cytosine), and uracil (only in RNA), and thymine (only in DNA). RNA polymers are generally single-stranded and lower molecular weight, while DNA is double-stranded and much higher molecular weight. This single strand (RNA) vs. double strand (DNA) difference is biochemically enormous in structure and functionality. Three kinds of RNA participate in protein synthesis from DNA: messenger RNA, transfer RNA, and ribosomal RNA. Many biochemistry textbooks and publications describe the remarkable details of the role of RNA in protein synthesis; see for example Hames and Harper (2000).

Shapiro (2010, p. 423) points out that, "the nucleotide components of RNA are substances of considerable chemical complexity, bearing four chiral centers, and the region-specific connection of the furanose form of the sugar ribose to a particular place on each of four heterocycle entities." Like many monosaccharides, ribose exists in equilibrium among five isomeric forms; one linear form, two five-membered rings (α- or β-ribofuranose), and two six-membered rings (α- or β-ribopyranose) (see Figure 3). The ribose in RNA consists only of the β-D-ribofuranose form of ribose, which is only about 18% of the equilibrium composition



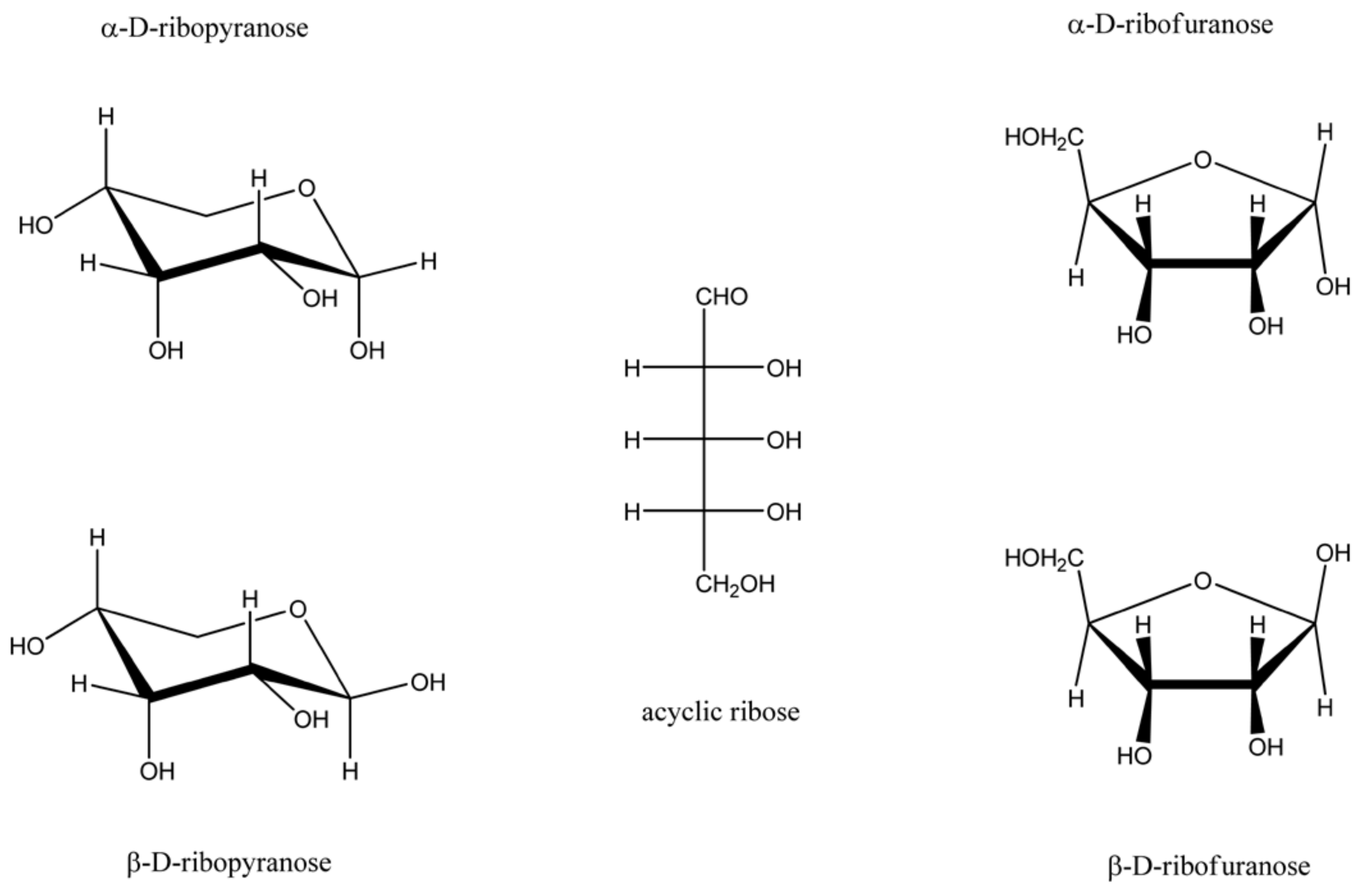
BASE= adenine, guanine, cytosine, thymine (DNA only), uracil (RNA only)

Figure 2. DNA and RNA nucleotide sequences

in solution among these five ribose isomers (Angyal, 1969). Shapiro (2010, p. 424) points out that too often "the progress that has been made by skilled chemists in this area [RNA world OoL hypothesis] more reflects an achievement [of organic chemists] in the total laboratory synthesis of RNA rather than any recapitulation of events on the early Earth." Failing to clearly distinguish a synthesis in a laboratory from either (1) possible prebiotic OoL chemistry or (2) what actually occurred in the history of the earth is a common practice among OoL researchers. The popular media also does not report or emphasize these differences. Equating the processes of laboratory syntheses and natural geochemistry does a disservice to the complexity of laboratory syntheses and downplays the practical impossibility of lifeless inorganic materials naturally combining within thermodynamic and historical constraints to form the complex biopolymers of life and ultimately to form cellular life. Shapiro (2010, p. 425) and many chemists "declare that the abiotic formation of RNA would constitute a near miracle."

Pross (2010, p. 435) argues against a metabolism-first OoL scenario based on proteins and argues for the RNA-first theory since incremental chemical evolution of polypeptides will pass through numerous transition or intermediate states, and any protein OoL pathway "cannot pass through non-functional intermediates." Pross's conclusion applies to the thermodynamic constraints and chemical stability of any OoL pathway from lifeless chemicals to observed cellular life, which presumably requires many transition states and intermediate materials.

While modern biochemistry and molecular biology continue to discover the amazing features and roles of RNA in living creatures, OoL researchers may be asking too much of one molecule in their quest for a pathway from lifeless chemicals to living cellular organisms. For example, Benner and Hutter (2002) concluded that the simultaneous roles of catalysis and information storage place incompatible demands on molecular structure of RNA. DNA has essentially the same chemical properties independent of its nucleotide sequence; a requirement of genetic information storage. But proteins provide a diverse range of chemical properties and functions specifically based on a particular amino acid sequence. RNA world proponents are searching for an OoL scenario where RNA accomplishes more genetic information storage, more catalysis, and more functionality than has been observed for RNA in living biochemical systems. A related OQ/OoL is the origin of the universal genetic code for all living creatures: the encoding of each



α-D-ribopyranose

β-D-ribopyranose

acyclic ribose

α-D-ribofuranose

β-D-ribofuranose

Figure 3. Isomeric forms of ribose

amino acid by one or more nucleotide triplets and the synthesis of all proteins (primary, secondary, tertiary, and quaternary structures) from sequences of DNA nucleotides.

Perhaps the greatest challenge to the RNA world OoL scenario is the stability of the nucleotides and the component sugars, phosphates, and heterocyclic base pairs. For example, Levy and Miller (1998, p. 7935) reported that "calculation of the half-lives for the rates of decomposition of the individual nucleobases A, U, G, C, and T clearly shows that these compounds are not stable on a geologic time scale at temperatures much above 0°C." Furthermore, Li and Breaker (1999, p. 5371) reported that "the rate constant for RNA transesterification [i.e., internal chemical rearrangements] under representative physiological conditions is ~100,000-fold greater than … for the hydrolysis of DNA under similar reaction conditions." Many factors affect RNA stability including pH, temperature, inorganic catalysts, UV radiation, etc. In a fallen world experiencing death and decay, every biopolymer is vulnerable to and eventually undergoes various degradation reactions. Our Creator has provided living organisms with numerous systems for protecting, repairing, and replacing critical proteins, DNA, and RNA that have been damaged. No OoL scenario has postulated the synthesis, storage, protection, and organization of biopolymers into living cellular creatures in the absence of these God-given protection, repair, and replacement strategies.

Critical unanswered scientific questions remain for the RNA world OoL scenario, including the following: (1) What prebiotic syntheses produced RNA or any mononucleotides? (2) What prebiotic mechanism achieved coupling the RNA units only in the 3'–5' configuration? (3) How were specific RNA macromolecular sequences synthesized in many identical copies in sufficient concentrations? (4) Within thermodynamic constraints, how could self-replication occur for a single molecular system? (See University of Leicester, 2012; EMFCSC, 2006.) Without a viable solution to any one of these four questions, the RNA world OoL hypothesis seems nearly impossible. Taken together, all the open, unanswered questions about the RNA world OoL hypothesis have led many researchers to abandon the RNA world OoL hypothesis and to conclude that a metabolism-first OoL scenario is more plausible.

Much of the RNA world hypothesis is driven by theoretical models. Science is anchored in actual observations in the real world (Pearcey and Thaxton, 1994). No mere rational deduction or prediction, no matter how sophisticated, can replace actual observed evidence. Vast computing power has been harnessed to produce incredible models, predictions, and forecasts, but in the absence of actual experimental evidence and real observations, models remain mere scientific prophecy subject to falsification or validation as soon as evidence is gathered and data is collected. All scientific evidence points to RNA as an essential part of all cellular life, but little to no evidence points to the abiogenesis of RNA apart from living creatures, which makes the RNA world OoL scenario an impossible route from lifeless chemicals to living cellular organisms.

OQ/OoL #4a: Is Life an Emergent Property?

OQ/OoL #4b: How Does Biology Emerge from Chemistry?

Traditionally, science seeks to reduce complex systems to their component parts and processes and then discover the "laws of nature" that describe those components in order to understand the whole complex system (Pearcey and Thaxton, 1994). Emergence is the scientific and philosophical idea that order, coherence, and complexity (which are not evident at the microscopic level) can arise at a macroscopic level far from equilibrium. Self-organization emerges from a disordered system through a myriad of individual interactions under a narrow range of constraints in energy, time, and space. Common examples of emergence in nature include snowflakes, sand dunes, clouds, flocking birds, and schooling fish. Emergence is a common theme in OoL research spanning, as Pohorille (2010, p. 384) concluded, "at least four types of emergent traits that are particularly relevant to the origins of cellular life: 1. organic/synthetic chemistry, 2. macromolecular and sub-cellular structures and functions, 3. metabolic and regulatory networks, 4. cellular behavior." While the scientific aspects for the "emergence" of chemistry from physics is well understood, OoL researchers have passionately (but unsuccessfully) pursued a similar understanding of the emergence of biology from chemistry.

With so many OQ/OoL and so little consensus on any aspect of the OoL pathway from lifeless chemicals to cellular life, the variety of individual emergence problems from chemistry to biology/cellular life is overwhelming. Pohorille (2012, p.429) succinctly described just one gap in the emergence of biochemistry: "The emergence of protein functions is a puzzle. … Structure (folding) is a prerequisite for function. Function … is a prerequisite for evolution. … Compact folds are rare among random amino acid chains. Then, how did protein functionality start?" Solving any one OQ/OoL on the emergence of biology and cellular life from chemistry and physics barely begins to comprehend the complexity of metabolic cycles and genetic systems of biopolymers. Pohorille (2012, p. 430) continues, "Explaining how [protocellular functions] originated, operated and evolved in a concerted, tightly regulated fashion is a major challenge."

All aspects of emergence in OoL scenarios have essentially no experimental data or scientific evidence to resolve these OQ/OoL on emergence. Nevertheless, emergence in OoL has attracted the attention of researchers from the disciplines of astronomy, biochemistry, biology, biophysics, chemistry, informatics, mathematics, philosophy, and physics. Prigogine (1972, p. 27) is perhaps the best-known contributor to theories on the nonequilibrium thermodynamics of "order through fluctuations," for which he won the Nobel Prize in Chemistry in 1977. Prigogine's work has inspired many to search for a fourth law of thermodynamics that would span the gaps between physics and biology and would explain the emergence of life. El-Diasty (2011, p. 30) concluded, "Present postulates on the origin of life do not satisfy the criteria of a scientific immensity theory … so is a fourth law needed for thermodynamics about the self-organizing phenomena observed in biology?" Critics of Prigogine's thermodynamic analysis on the origin of life, including Morris (1978) and Gish (1978), emphasize the speculative nature of emergent hypotheses on the OoL and the lack of experimental evidence or verification.

At the recent conferences on the OQ/OoL, presenters sought inspiration for and explanations of emergence from (1) Darwinian evolution, (2) nonlinear, chaotic, and random systems, (3) Gödel's theorems and algorithms, (4) autocatalytic sets, and (5) competitive coherence. The clear conclusion is that while the problems of emergence in OoL are vast, the scientific inquiry on these OQ/OoL is in its infancy and is dominated by conjecture, supposition, and hypotheses. In Genesis 1, Scripture reveals that biology, chemistry, physics, and all creation emerged when "God said, 'Let there be.…'" Since Creation was a discontinuity in history, the OoL search for a continuous, naturalistic path from lifeless chemicals to cellular life, including the emergence of biology from chemistry and physics, will continue to be a futile and unsuccessful quest.

Conclusion

While many OoL contributors danced around the issue, one conference directly asked—but failed to answer—the OQ/OoL: What evidence is necessary to prove how life originated? (University of Leicester, 2012). As with evolution, a detailed theory of OoL remains elusive, but scientists overwhelmingly, enthusiastically, and optimistically still persist in the belief that naturalistic answers will eventually be found. Wieczorek (2012, p. 7) described the goal of OoL: "[A] proper theory for the origins-of-life should propose a logical chain of events that would start with prebiotic soup and end with a living organism." Such vague descriptions of the OoL goals are sufficient to gain consensus but not comprehensive enough to risk falsifiability. Falsification remains a widely accepted criterium for valid scientific theories and explanations. Alpermann et al. (2010, p. 404) raised an inconvenient truth for the modern study of naturalistic OoL: "Does this impossibility of falsification of any [OoL] hypothesis mean that there is a philosophical hypothesis left, the hypothesis of a supernatural Creator, who brings the process of origin of life into being?"

Perhaps the only agreement within the naturalistic OoL community is that science does not have a naturalistic or materialistic answer to the origin of life on earth and that modern science may never provide an answer. Pizzarello (2010, p. 378) candidly captured the limited progress in the field of OoL research: "There is exceedingly little knowledge about the actual origin(s) of life." Stano (2010, p. 454) seconded the conclusion, when he stated, "We simply do not know and perhaps we will never know the exact historical sequence of the events that lead to living cells." Many conference participants proposed, postulated, and speculated on a wide range of answers to the interrelated OQ/OoL, each providing more research possibilities than actual evidence or experimental results. At this point in the history of their research endeavors, OoL scientists may need more humility. For example, in the 1950s, after Miller presented the results of the experiments synthesizing organic compounds under supposed primitive-earth conditions at a seminar at the University of Chicago, Nobel Prize winner Harold Urey was asked by Enrico Fermi, "I understand that you and Miller have demonstrated that this is one path by which life might have originated. Harold, do you think it was the way?" Urey replied, "Let me put it this way, Enrico. If God didn't do it this way, he overlooked a good bet!" (Arnold, et al., 1995). Currently, most OoL researchers do not accept the reducing atmosphere in the early earth assumed by Miller and Urey. With the myriad of OQ/OoL, future researchers may come along and discover answers and explanations that everyone else missed, including that no naturalistic pathway could have possibly ever existed from lifeless chemicals to living, cellular organisms. As their naturalistic assumptions lead to more scientific contradictions and as the "modern" answers to how life originated become increasingly impossible to believe, the account of Creation in Genesis and throughout Scripture will prove to be the only viable explanation for the origin of all living creatures and the created world.

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References

Alpermann, T., K. Rüdel, R. Rüger, N. Knoepffler, A. Fahr, and W. Weigand. 2010. Heterotrophic versus autotrophic scenarios. *Origins of Life and Evolution of Biospheres* 40(4–5):402–405.

Angyal, S.J. 1969. The composition and conformation of sugars in solution. *Angewandte Chemie International Edition* 8(3):157–226.

Arnold, J.R., J. Bigeleisen, C.A. Hutchinson Jr. 1995. *Harold Clayton Urey: A Biographical Memoir*. National Academies Press, Washington, DC. http://www.nasonline.org/publications/biographical-memoirs/memoir-pdfs/urey-harold.pdf

Astrobiology Workshop. 2009. Open questions on the origins of life. San Sebastian, Spain, May 20–23. http://astrobiology.com/2009/01/astrobiology-workshop-open-questions-on-the-origins-of-life.html

Benner, S.A., and D. Hutter. 2002. Phosphates, DNA, and the search for nonterrean life: a second generation model for genetic molecules. *Bioorganic Chemistry* 30:62–80.

EMFCSC. 2006. Basic questions about the origin of life. Erice, Sicily, October 2–6. www.plluisi.org/sito-erice2006/origin.htm

El-Diasty, F. 2011. Origin of order: emergence and evolution of biological organization as a problem in thermal physics. *Advances in Life Sciences* 1(1):30–39.

Gish, D. 1978. Thermodynamics and the origin of life (part II). *Acts & Facts* 7 (4).

Hames, B.D., and N.M. Hooper. 2000. *Instant Notes: Biochemistry*, second ed. Springer-Verlag, New York, NY.

Hazen, R.H. 2005. *Origins of Life*. DVD. The Teaching Company, Chantilly, VA (http://www.thegreatcourses.com/tgc/courses/course_detail.aspx?cid=1515).

Jortner, J. 2006. Conditions for the emergence of life on the early earth: summary and reflections. *Philosophical Transactions of the Royal Society B* 361:1877–1891.

Lahava, N., S. Nira, and A.C. Elitzurb. 2001. The emergence of life on earth. *Progress in Biophysics & Molecular Biology* 75:75–120.

Levy, M., and S.L. Miller. 1998. The stability of the RNA bases: implications for the origin of life. *Proceedings of the National Academy of Science, USA* 95:7933–7938.

Li, Y., and R.R. Breaker. 1999. Kinetics of RNA degradation by specific base catalysis of transesterification involving the 2'-hydroxyl group. *Journal of the American Chemical Society* 121:5364–5372.

Luisi, P.L., P. Walde, and T. Oberholzer. 1999. Lipid vesicles as possible intermediates in the origin of life. *Current Opinion in Colloids and Interface Science* 4(1):33–39.

Luisi, P.L., and K. Ruiz-Mirazo. 2010. Open questions on the origins of life: introduction to the special issue. *Origins of Life and Evolution of Biospheres* 40(4–5):353–355.

Mansy, S.S. 2010. Experimental model protocells support a heterotrophic origin of life. *Origins of Life and Evolution of Biospheres* 40(4–5):394–397.

Morris, H. 1978. Thermodynamics and the origin of Life (part I). *Acts & Facts* 7 (3).

Murphy, P.M. 2013. Understanding the origin of homochirality in amino acids and polypeptides. *Creation Research Society Quarterly* 50:78–88.

Norris, V., C. Loutelier-Bourhis, and A. Thierry. 2012. How did metabolism and genetic replication get married? *Origins of Life and Evolution of Biospheres* 42(5):487–495.

Oparin, A.I. (1936) 1952. *The Origin of Life*. English translation. Dover, New York, NY.

OQOL 2009. Selected list of questions. http://oqol2009.wordpress.com/questions/selected-list-of-questions

Pascal, R. 2010. The combination of chemical, biochemical, and geological arguments favours heterotrophic scenarios. *Origins of Life and Evolution of Biospheres* 40(4–5):391–394.

Pascal, R. 2012. Where did life begin? *Open Questions On The Origin Of Life 2012*, http://www.physics.le.ac.uk/oqol2012/resources/OQOL2012-Updated_programme-16_04_2012.pdf

Pearcey, N.R., and C.B. Thaxton. 1994. *The Soul of Science*. Crossway Books, Wheaton, IL.

Pereto, J. 2005. Controversies on the origin of life. *International Microbiology* 8:23–31.

Pizzarello, S. 2010. The chemistry that preceded life's origin: when is an evolutionary story an emergent story? *Origins of Life and Evolution of Biospheres* 40(4–5):378–380.

Pohorille, A. 2010. Emerging properties in the origins of life and Darwinian evolution. *Origins of Life and Evolution of Biospheres* 40(4–5):384–386.

Pohorille, A. 2012. Processes that drove the transition from chemistry to biology: concepts and evidence. *Origins of Life and Evolution of Biospheres* 42(5):429–432

Pross, A. 2010. Commentary on "Plausibility of an RNA World." *Origins of Life and Evolution of Biospheres* 40(4–5):434–437.

Prigogine, I., G. Nicolis, and A. Babloyants. 1972. Thermodynamics of evolution. *Physics Today* 25:23–28.

Shapiro, R. 2010. On the likelihood of the abiotic formation of RNA molecules. *Origins of Life and Evolution of Biospheres* 40(4–5):423–425.

Smith, E., and H.J. Morwitz. 2010. The autotrophic origins paradigm and small-molecule organocatalysis. *Origins of Life and Evolution of Biospheres* 40(4–5):398–402.

Stano, P. 2010. Minimal and primitive cells in origins of life, systems chemistry and synthetic biology. *Origins of Life and Evolution of Biospheres* 40(4–5):452–457.

University of Leicester. 2012. Open questions on the origin of life 2012: Programme and abstracts. April 16. http://www.physics.le.ac.uk/oqol2012/programme.html

Vaidya, N., M.L. Manapat, I.A. Chen, R. Xulvi-Brunet, E.J. Hayden, and N. Lehman. 2012. Spontaneous network formation among cooperative RNA replicators. *Nature* 491(7422):72–77.

Voet, D., and J. Voet. 2004. *Biochemistry*, 3rd ed. John Wiley & Sons, Hoboken, NJ.

Wieczorek, R. 2012. How does biology emerge from chemistry? *Open Questions On The Origin Of Life 2012*, http://www.physics.le.ac.uk/oqol2012/resources/OQOL2012-Updated_programme-16_04_2012.pdf

Witze, A. 2013. NASA funding shuffle alarms planetary scientists. *Nature News*, December 4, 2013. doi:10.1038/nature.2013.14304.

Zaia, D.A., and C.T. Zaia. 2008. Some controversy about the origin of life. *Química Nova* 31(6):1599–1602.

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Notes from the Panorama of Science

Mislabeling Crabs and Creationists

Last summer, in Baltimore, I enjoyed eating "Chesapeake Bay blue crab"—but was that what I actually ate? Why am I suspicious?

> Blue crab, the Chesapeake Bay's most iconic edible species, also appears to be its most impersonated. A report released April 1 [2015] … found that 38 percent of crab cakes labeled as local on menus in the region were made of an entirely different species of crab, predominantly one imported form the Indo-Pacific region. In Annapolis and Baltimore, nearly 50 percent of "Maryland" and "Chesapeake Bay" crab cakes were mislabeled. (Pipkin, 2015)

Before getting crabby about such false advertising (a type of bait-and-switch deception), such crustacean counterfeiting should be verified. How can portunid pretenses be proven?

> "I've put a lot of seafood in my purse over the last few years," said Dr. Kimberly Warner, author of the report … [referring to] crab cake samples that she and other testers collected [and] shipped to a lab in Florida that determined whether the cakes contained blue crab, *Callinectes sapidus*, and, if not, which species were used instead. Warner said the fraud rate of 38 percent is a conservative estimate. … Mislabeling "is being done because it's easier to sell a Maryland crab cake than one from the Philippines or Vietnam" [said Steve Vilnit, of Maryland's Department of Natural Resources]. (Pipkin, 2015)

The report lamented that bogus brachyurans are part of a treacherous trend of tricking tastebuds:

> Maryland's favorite seafood dish is not safe from a bait and switch. When diners are expecting the fresh, distinctive flavor of the Chesapeake blue crab, they may instead be served a completely different species, shipped from as far away as Indonesia. ... This mislabeling rate is consistent with Oceana's previous studies on fish and shrimp. In 2013, Oceana found that one-third of more than 1,200 fish samples were mislabeled according to [USDA] guidelines. We also found 30 percent of shrimp samples to be misrepresented to consumers in a similar study in 2014. (Warner et al., 2015)

Many restaurants, buffets, and sushi bars are swimming in similar seafood scams. Piscatorial masquerades include pollock playing cod, icefish as anchovies, tilapia as grouper, and rockfish as red snapper. Customers, who eagerly eat what is falsely advertised as "albacore" or "white tuna," may experience a digestive insult: the look-alike meat of *escolar* fish (aka snake mackerel) is wax-loaded and promptly produces a blasting vermillion diarrhea.

So, buyer, beware of seafood mislabeling.

Yet there are worse bait-and-switch scams to warily watch out for, such as "creation apologetics" ministry mislabeling. Not all that is called "biblical" origins science is genuinely true to Genesis.

Some *unfaithful-to-Genesis* organizations overtly disclose their "creation-by-evolution" doctrines. However, most do not conspicuously admit it, when compromising the Bible's record of origins.

But you can recognize *real messages*, of ministries or "experts," by their compatibility with Genesis.

Does the advertised "creation" teaching follow the uniformitarian dogma and eons of deep time of deists Charles Lyell and James Hutton? Does it incorporate Monsignor Lemaître's big bang theory? Does it promote or defend the descent-with-modification sophistry of Charles Darwin and Thomas Huxley, or the phylogenetic recapitulation fraud of Ernst Haeckel? Does it presuppose death before Adam, like Alexander Winchell or William Dembski, within some kind of pre-Adamite "hominids-morphing-into-humans" scenario?

When scrutinizing the true ingredients—crab or shrimp or tunafish—in seafood cuisine, forensic genetics can detect the telltale DNA of the seafood actually sold. However, when scrutinizing whether an "apologetics expert" is truly a *biblical creationist*, compare what those "experts" teach, specifically with what the Scripture teaches (Acts 17:11).

James J. S. Johnson
Institute for Creation Research

References

Pipkin, Whitney. 2015. Nearly 40% of blue crab mislabeled in Chesapeake area eateries. *Chesapeake Bay Journal* 25(3): 7 (May).

Warner, Kimberly, Beth Lowell, Carlos Disla, Kate Ortenzi, Jacqueline Savitz, and Michael Hirshfield. 2015. Oceana reveals mislabeling of iconic Chesapeake blue crab. 2015. http://usa.oceana.org/sites/default/files/crab_testing_report_final_3.27.15.pdf .

Letters to the Editor

The policy of the editorial staff of CRSQ *is to allow letters to the editor to express a variety of views. As such, the content of all letters is solely the opinion of the author, and does not necessarily reflect the opinion of the* CRSQ *editorial staff or the Creation Research Society.*

iDINO Corrections

Thanks for the Spring 2015 special issue of the *CRSQ* containing the special report on the iDINO Project.

However, I noticed two factual errors in the Thomas and Nelson paper on “Radiocarbon in Dinosaur and Other Fossils” (pp. 299–311) that should have been avoided if the authors had properly read the paper they were referencing for the source of their data. I refer to Snelling (1998), from which paper on page 306 they refer to “fossil wood extracted from the middle Triassic Hawkesbury Sandstone of Queensland.” First, the authors contradict themselves in the very next sentence, where they correctly report the Hawkesbury Sandstone is in the Sydney area, which is NOT in Queensland. Thus, the first factual error should have been noticed by the reviewers and the editor. Second, if the authors had properly read the source paper, they would have correctly reported that the fossil wood was extracted from the Permian Newcastle Coal Measures north of Sydney.

These two factual errors do not engender confidence in the authors’ ability to handle the radiocarbon data they report. That is a pity, as their contribution provided some food for thought, even though their data set being small didn’t really enable significant conclusions to be drawn, apart from their assertion the radiocarbon would appear to be intrinsic to the fossils, thus dating them as very young, contrary to their conventional ages.

Yours sincerely,
Andrew Snelling.

Media Reviews

Evolution's Achilles' Heels: Ph.D. Scientists Explain Evolution's Fatal Flaws in Areas Claimed to be Its Greatest Strengths

Book and DVD,
Edited by Robert Carter

Creation Book Publishers,
Powder Springs, GA, 2014,
Book 272 pages, $14.00;
DVD 96 min., $19.00

This well-documented exposé of the fatal flaws in evolutionary science is presented by 9 scientists in the book and 15 scientists in the DVD. The flaws are in areas of study considered to be the greatest strengths of evolution. They include the origin of life, mutations and natural selection, the fossil record, the geological record, cosmology, radiometric dating, and ethics and morality.

The origin of life from chemicals is especially inimical to evolution despite 60 plus years of experimentation. I like to compare the progress made by evolutionists to climbing the first micron upward on Mount Everest. The problems are incredible, as summarized by Jonathan Sarfati. One such problem is the "chicken and egg" predicament: For DNA to be translated, one needs decoding machinery that is made by the DNA itself. Moreover, some molecular machines, including the bacterial flagellum, need all parts working together or they cannot succeed. There also is the major problem that all amino acids in proteins of animals are left-handed while all information indicates we should have a 50% left and 50% right-handed mixture.

The mechanism of evolution is amplified by Don Batten and Robert Carter. Mutations are practically all harmful or neutral at best and cannot produce new organs and tissues. Besides this, the DNA molecule is a huge information storage medium that is exceedingly complicated. Information does not originate from pure matter but instead is a sign of intelligence. The idea of "junk DNA" also is debunked. Natural selection is not the same as evolution. It is not original to Darwin, is too slow to produce new categories of life, and is observed to be a conserving process rather than creative.

Emil Silvestru shows that the fossil record does not support evolution but instead creation of kinds with some variability within those kinds. The record is composed of gaps and does not show the slow progress of one organism into another. The most devastating evidence against evolution from the fossil record is the sudden appearance of numerous phyla of organisms with no ancestors in the "Cambrian Explosion."

The geologic record, although thought to be explained by uniformitarianism, deep time, and evolution, shows many features contrary to those assumptions, as outlined by Tas Walker. It has been found that many physical processes assumed to be slow can occur rapidly, and the dynamics of Noah's Flood can explain practically all such slow processes. Sedimentary rocks covering vast areas, the lack of erosion between layers, the distant transport of hard rocks, erosional remnants, and water and wind gaps defy gradualism but can readily be explained by the Flood.

John Hartnett shows that there are many problems in evolutionary cosmology, especially with the big bang theory. Five unknowns are used to explain aspects of the big bang: (1) galaxy redshifts, supposedly explained by the expansion of space; (2) cosmic background radiation, assumed to be the afterglow of the big bang; (3) problematic rotation curves of spiral galaxies, explained by unobserved dark matter; (4) supernovae thought to dim with distance due to an accelerating universe, explained by dark energy; and (5) flatness and isotropy of the universe, explained by inflation.

Jim Mason explains radiometric dating, pointing out the three main assumptions behind the dates, some of which are in error by five orders of magnitude. Carbon-14 dating does not date rocks but instead carbon-bearing materials that are believed to be less than about 90,000 years old. Yet coal is dated by carbon-14, even though coal is assumed to be 15 to 350 million years old. Diamonds, claimed to be a billion or more years old, also contain carbon-14 traces. Based on helium leakage in zircon crystals, the age of the zircons is determined to be 6 thousand years, while the uranium-lead age gives 1.5 billion years. This difference suggests that the Earth underwent a previous period of accelerated radiometric decay.

The last chapter deals with ethics and morality, as presented by David Catchpoole and Mark Harwood. There is no basis for morality and ethics in evolution, as amply displayed by the horrific abuses of applying evolution to society. These abuses, part of social Darwinism, include eugenics, genocide, wars, and the Holocaust.

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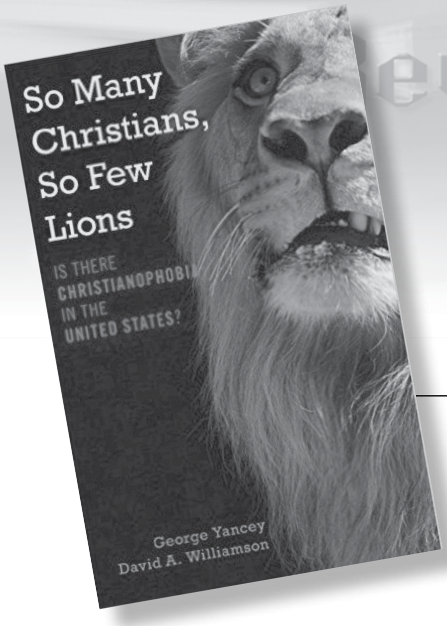
So Many Christians, So Few Lions
IS THERE CHRISTIANOPHOBIA IN THE UNITED STATES?
George Yancey
David A. Williamson

So Many Christians, So Few Lions: Is There Christianophobia in the United States?

by George Yancey and David A. Williamson

Rowman & Littlefield Publishers, Lanham, MD, 2014, 205 pages, $35.00

This well-researched book documents the anti-Christian hostility that is widespread in America among academics, judges, and other well-educated persons, as well as the political left. The authors, both highly respected professors of sociology at the University of North Texas, use sociological concepts and several empirical sociological studies to document their case for widespread anti-Christian hostility in America. By Christianity the authors are referring primarily to conservative Christians, often meaning those persons who take their faith seriously, as opposed to nominal or Sunday-only Christians.

Especially targeted by what the authors define as a hate movement are those Christians who take so-called conservative stands on certain political issues. This includes Darwin doubters, creationists, and those labeled pro-life, pro-marriage and pro-family. The authors define terms such as intolerance, bias, bigotry, and even hatred and then document their conclusion that the behavior of Christianophobics fits these definitions. They also include a paragraph defining and defending the use of the word *Christianophobia*, a term they acknowledge is not original with them.

The authors document in detail anti-Christian activity in which Christianophobics are involved. Much of the data come from a detailed survey of members of organizations that one would expect attracts anti-Christians, such as the National Association of Science Education. An analysis of the comments of the 3,577 respondents make up a significant part of the book. Yancey and Williamson also use data from the National Election Survey to further explore their thesis. In this survey they "were surprised to find a relatively high level of animosity toward conservative Christians" (p. 2). One conclusion is that even though the anti-Christian population is a minority, as a whole they are very well educated and hold positions of power and influence in America. This book was published by a mainline academic publisher, which finally is documenting this major social problem in the West. The book includes numerous tables; notes and references alone run to 37 pages.

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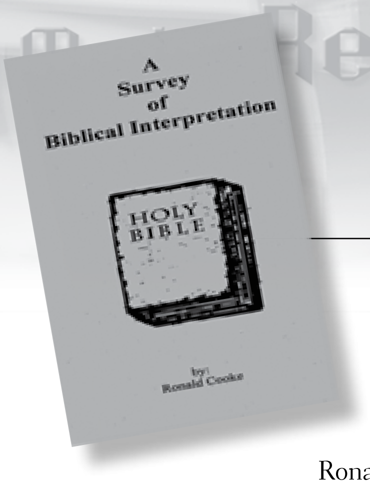

A Survey of Biblical Interpretation

by Ronald Cooke

Truth International Ministries,
Max Meadows, VA, 2012,
176 pages, $10.00

Ronald Cooke served as president of Breckbill Bible College in Virginia for more than 30 years with faithful preaching, pastoring, writing, and missionary work extending his ministry to over 60 years. In its ninth printing since 1982, this book is a tremendous resource for the pastor, teacher, or layman in conducting proper biblical exegesis.

Unlike some intimidating treatises on hermeneutics that insist the interpreter have a thorough knowledge in diverse fields from geography to politics and everything in between (Terry, pp. 23–28), Cooke's work is written for the average reader and reminds us that "biblical interpretation is a must for every Christian" (p. 84). As such, the book is designed to assist the layman in "rightly dividing the Word of Truth" (2 Tim. 2:15) and provides specific examples where faulty interpretations result when consistent exegetical methods are ignored.

Packed with fascinating information concerning various schools of interpretation throughout church history, Cooke's survey is a delight to read. As an introductory work on the subject, complex technicalities of Greek grammar, for example, are avoided in favor of a profitable overview of the history of interpretive methods. Cooke does not overlook the importance of studying the original languages and is well educated in them himself, yet in no way does he limit the work of biblical interpretation to scholars.

The book is divided into two parts. First, Cooke exhibits a humility and balanced approach in assessing both the history of interpretive methods and the key figures associated with schools of interpretation. He notes both the valuable contributions and the regrettable influences of theologians ranging from the rabbinic era up through the Reformation, to the degeneration of exegesis by way of German rationalism and higher criticism. It is surprising to learn how severely the literal method of interpretation was suppressed by allegorists for most of church history. The outright rejection of the literal interpretation became the indispensable foundation needed to justify a multitude of doctrinal aberrations. "True exegesis always suffers when men become more concerned with issues rather than the text of Scripture. In modern times men have invented the Gap Theory to 'save' Christianity from the attacks of the evolutionary geologists. God's Word does not need to be 'saved' from the attacks of the critics; it just needs to be interpreted correctly" (p. 13).

Part two of the book explores the rules of biblical interpretation. Presuppositions are addressed, as well as explanations on how to properly treat symbols, colors, numbers, figurative language, idioms, prophecy, etc. The information contained here is indispensable for every Christian. Cooke emphasizes the fact that pride and dogmatism have no place in formulating doctrines that are not clearly stated or can be logically deduced from the biblical text.

Cooke holds firmly to the inspiration, inerrancy, authority, and perspicuity of Scripture. He writes:

> The object of all true interpretation is to find out what the Scriptures demand of us and not what we demand of them.
>
> It has become fashionable in some areas to make the statement that the Scriptures have to be interpreted in a certain way in order to meet the demands of geology. Certain writers indicate that this is their position: that in order to meet the demands of modern science thus and so has to be done. The true Scriptural exegete is not concerned with the 'demands' of modern geology. To begin with, Geology [*sic*] is an infant science … Geology is not in a position to make 'demands' upon the Bible, even if it was an ancient science. The Bible makes any 'demands' that are going to be made. It is up to man to bring his findings into conformity with that which God has revealed" (p. 106).

Considering the importance of proper biblical interpretation for every Christian, this work is highly recommended. Its value far exceeds the suggested donation amount. Dr. Cooke's many books and tracts are available through www.truthinternationalministries.com.

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Reference

Terry, M.S. 1890. *Biblical Hermeneutics*. Eaton & Mains, New York, NY.

Instructions to Authors

Submission

Electronic submissions of all manuscripts and graphics are preferred and should be sent to the editor of the *Creation Research Society Quarterly* in Word, WordPerfect, or Star-Office/Open Office (see the inside front cover for address). Printed copies also are accepted. If submitting a printed copy, an original plus two copies of each manuscript should be sent to the editor. The manuscript and copies will not be returned to authors unless a stamped, self-addressed envelope accompanies submission. If submitting a manuscript electronically, a printed copy is not necessary unless specifically requested by the *Quarterly* editor. Manuscripts containing more than 35 pages (double-spaced and including references, tables, and figure legends) are discouraged. An author who determines that the topic cannot be adequately covered within this number of pages is encouraged to submit separate papers that can be serialized.

All submitted manuscripts will be reviewed by two or more technical referees. However, each section editor of the *Quarterly* has final authority regarding the acceptance of a manuscript for publication. While some manuscripts may be accepted with little or no modification, typically editors will seek specific revisions of the manuscript before acceptance. Authors will then be asked to submit revisions based upon comments made by the referees. In these instances, authors are encouraged to submit a detailed letter explaining changes made in the revision, and, if necessary, give reasons for not incorporating specific changes suggested by the editor or reviewer. If an author believes the rejection of a manuscript was not justified, an appeal may be made to the *Quarterly* editor (details of appeal process at the Society's web site, www.creationresearch.org).

Authors who are unsure of proper English usage should have their manuscripts checked by someone proficient in the English language. Also, authors should endeavor to make certain the manuscript (particularly the references) conforms to the style and format of the *Quarterly*. Manuscripts may be rejected on the basis of poor English or lack of conformity to the proper format.

The *Quarterly* is a journal of original writings, and only under unusual circumstances will previously published material be reprinted. Questions regarding this should be submitted to the Editor (CRSQeditor@creationresearch.org) prior to submitting any previously published material. In addition, manuscripts submitted to the *Quarterly* should not be concurrently submitted to another journal. Violation of this will result in immediate rejection of the submitted manuscript. Also, if an author uses copyrighted photographs or other material, a release from the copyright holder should be submitted.

Appearance

Manuscripts shall be computer-printed or neatly typed. Lines should be double-spaced, including figure legends, table footnotes, and references. All pages should be sequentially numbered. Upon acceptance of the manuscript for publication, an electronic version is requested (Word, WordPerfect, or Star-Office/Open Office), with the graphics in separate electronic files. However, if submission of an electronic final version is not possible for the author, then a cleanly printed or typed copy is acceptable.

Submitted manuscripts should have the following organizational format:

1. Title page. This page should contain the title of the manuscript, the author's name, and all relevant contact information (including mailing address, telephone number, fax number, and e-mail address). If the manuscript is submitted by multiple authors, one author should serve as the corresponding author, and this should be noted on the title page.

2. Abstract page. This is page 1 of the manuscript, and should contain the article title at the top, followed by the abstract for the article. Abstracts should be between 100 and 250 words in length and present an overview of the material discussed in the article, including all major conclusions. Use of abbreviations and references in the abstract should be avoided. This page should also contain at least five key words appropriate for identifying this article via a computer search.

3. Introduction. The introduction should provide sufficient background information to allow the reader to understand the relevance and significance of the article for creation science.

4. Body of the text. Two types of headings are typically used by the *CRSQ*. A major heading consists of a large font bold print that is centered in column, and is used for each major change of focus or topic. A minor heading consists of a regular font bold print that is flush to the left margin, and is used following a major heading and helps to organize points within each major topic. Do not split words with hyphens, or use all capital letters for any words. Also, do not use bold type, except for headings (italics can be occasionally used to draw distinction to specific words). Italics should not be used for foreign words in common usage, e.g., "et al.", "ibid.", "ca." and "ad infinitum." Previously published literature should be cited using the author's last name(s) and the year of publication (ex. Smith, 2003; Smith and Jones, 2003). If the citation has more than two authors, only the first author's name should appear (ex. Smith et al., 2003). Contributing authors should examine this issue of the *CRSQ* or consult the Society's web site for specific examples as well as a more detailed explanation of manuscript preparation. Frequently-used terms can be abbreviated by placing abbreviations in parentheses following the first usage of the term in the text, for example, polyacrylamide gel electrophoresis (PAGE) or catastrophic plate tectonics (CPT). Only the abbreviation need be used afterward. If numerous abbreviations are used, authors should consider providing a list of abbreviations. Also, because of the variable usage of the terms "microevolution" and "macroevolution," authors should clearly define how they are specifically using these terms. Use of the term "creationism" should be avoided. All figures and tables should be cited in the body of the text, and be numbered in the sequential order that they appear in the text (figures and tables are numbered separately with Arabic and Roman numerals, respectively).

5. **Summary.** A summary paragraph(s) is often useful for readers. The summary should provide the reader an overview of the material just presented, and often helps the reader to summarize the salient points and conclusions the author has made throughout the text.

6. **References.** Authors should take extra measures to be certain that all references cited within the text are documented in the reference section. These references should be formatted in the current *CRSQ* style. (When the *Quarterly* appears in the references multiple times, then an abbreviation to *CRSQ* is acceptable.) The examples below cover the most common types of references:

Robinson, D.A., and D.P. Cavanaugh. 1998. A quantitative approach to baraminology with examples from the catarrhine primates. *CRSQ* 34:196–208.

Lipman, E.A., B. Schuler, O. Bakajin, and W.A. Eaton. 2003. Single-molecule measurement of protein folding kinetics. *Science* 301:1233–1235.

Margulis, L. 1971a. The origin of plant and animal cells. *American Scientific* 59:230–235.

Margulis, L. 1971b. *Origin of Eukaryotic Cells*. Yale University Press, New Haven, CT.

Hitchcock, A.S. 1971. *Manual of Grasses of the United States*. Dover Publications, New York, NY.

Walker, T.B. 1994. A biblical geologic model. In Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism* (technical symposium sessions), pp. 581–592. Creation Science Fellowship, Pittsburgh, PA.

7. **Tables.** All tables cited in the text should be individually placed in numerical order following the reference section, and not embedded in the text. Each table should have a header statement that serves as a title for that table (see a current issue of the *Quarterly* for specific examples). Use tabs, rather than multiple spaces, in aligning columns within a table. Tables should be composed with *14-point type* to insure proper appearance in the columns of the *CRSQ*.

8. **Figures.** All figures cited in the text should be individually placed in numerical order, and placed after the tables. Do not embed figures in the text. Each figure should contain a legend that provides sufficient description to enable the reader to understand the basic concepts of the figure without needing to refer to the text. Legends should be on a separate page from the figure. All figures and drawings should be of high quality (hand-drawn illustrations and lettering should be professionally done). Images are to be a minimum resolution of 300 dpi at 100% size. Patterns, not shading, should be used to distinguish areas within graphs or other figures. Unacceptable illustrations will result in rejection of the manuscript. Authors are also strongly encouraged to submit an electronic version (.cdr, .cpt, .gif, .jpg, and .tif formats) of all figures in individual files that are separate from the electronic file containing the text and tables.

Special Sections

Letters to the Editor:

Submission of letters regarding topics relevant to the Society or creation science is encouraged. Submission of letters commenting upon articles published in the *Quarterly* will be published two issues after the article's original publication date. Authors will be given an opportunity for a concurrent response. No further letters referring to a specific *Quarterly* article will be published. Following this period, individuals who desire to write additional responses/comments (particularly critical comments) regarding a specific *Quarterly* article are encouraged to submit their own articles to the *Quarterly* for review and publication.

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Occasionally, the editor will invite individuals to submit differing opinions on specific topics relevant to the *Quarterly*. Each author will have opportunity to present a position paper (2000 words), and one response (1000 words) to the differing position paper. In all matters, the editor will have final and complete editorial control. Topics for these forums will be solely at the editor's discretion, but suggestions of topics are welcome.

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All book reviews should be submitted to the book review editor, who will determine the acceptability of each submitted review. Book reviews should be limited to 1000 words. Following the style of reviews printed in this issue, all book reviews should contain the following information: book title, author, publisher, publication date, number of pages, and retail cost. Reviews should endeavor to present the salient points of the book that are relevant to the issues of creation/evolution. Typically, such points are accompanied by the reviewer's analysis of the book's content, clarity, and relevance to the creation issue.

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Creation Research Society

History—The Creation Research Society was organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a need for an association devoted to research and publication in the field of scientific creation, with a current membership of over 600 voting members (graduate degrees in science) and about 1000 non-voting members. The *Creation Research Society Quarterly* is a peer-reviewed technical journal. It has been gradually enlarged and modified, and is currently recognized as one of the outstanding publications in the field. In 1996 the *CRSQ* was joined by the newsletter *Creation Matters* as a source of information of interest to creationists.

Activities—The Society is a research and publication society, and also engages in various meetings and promotional activities. There is no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund and research center are maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible. As part of its vigorous research and field study programs, the Society operates The Van Andel Creation Research Center in Chino Valley, Arizona.

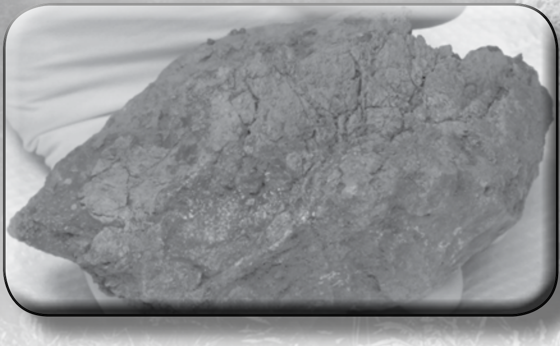
Membership—Voting membership is limited to scientists who have at least an earned graduate degree in a natural or applied science and subscribe to the Statement of Belief. Sustaining membership is available for those who do not meet the academic criterion for voting membership, but do subscribe to the Statement of Belief.

Statement of Belief—Members of the Creation Research Society, which include research scientists representing various fields of scientific inquiry, are committed to full belief in the biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution) both of the universe and the earth with its complexity of living forms. We propose to re-evaluate science from this viewpoint, and since 1964 have published a quarterly of research articles in this field. *All members of the Society subscribe to the following statement of belief:*

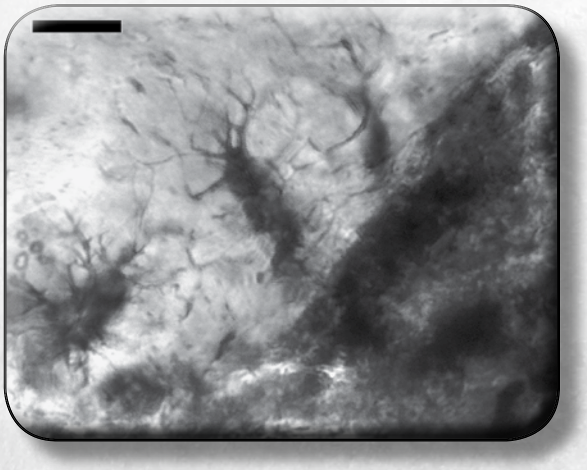
1. The Bible is the written Word of God, and because it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.
2. All basic types of living things, including humans, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.
3. The Great Flood described in Genesis, commonly referred to as the Noachian Flood, was a historical event worldwide in its extent and effect.
4. We are an organization of Christian men and women of science who accept Jesus Christ as our Lord and Savior. The act of the special creation of Adam and Eve as one man and woman and their subsequent fall into sin is the basis for our belief in the necessity of a Savior for all people. Therefore, salvation can come only through accepting Jesus Christ as our Savior.

iDINO II

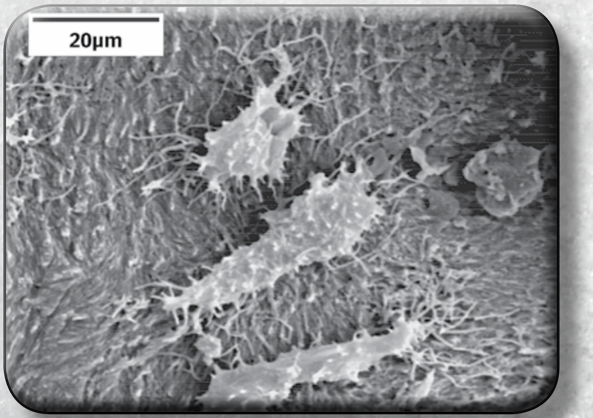
Investigation of Dinosaur Intact Natural Osteo-tissue



A fragment of the *Triceratops* brow horn. Fragments, such as this one, still contain tissue and cells.



Microscopic examination of tissue extracted from a *Triceratops* horn reveals bone cells still present.



Electron microscope picture of intact bone cells still in tissue extracted from a *Triceratops* horn.

How can pliable, stretchable tissue survive inside dinosaur fossils for over 65 million years?

How can this tissue still contain intact cells and even dinosaur proteins?

How can this fragile biological material survive for so long?

The answer to these questions directly challenges the current, evolutionary-biased, geologic timescale.

The Creation Research Society began its iDINO research initiative for the purpose of studying soft tissue in dinosaur fossils. The first phase of the project detected pliable, unfossilized tissue in a brow horn of a *Triceratops*. Within this tissue were intact osteocytes (bone cells). Some results from the iDINO project have been published in a technical microscopy journal and presented at an international microscopy conference. The Spring 2015 issue of the *Creation Research Society Quarterly* also features a special report of the iDINO project. Plus, to further spread the important information about soft-tissue, the Society is developing a video (Echoes of the Jurassic).

The **second phase** of the project (iDINO II) will look more extensively at the process of tissue preservation. Evolutionists have offered various theories of how this tissue could survive for millions of years. iDINO II will methodically investigate these preservation claims, assessing their plausibility.

The iDINO results have already provided a strong challenge to the evolutionary worldview. More extensive and detailed examination may provide even stronger evidence that the age of dinosaur fossils is far less than 65 million years. To this end, the Society continues to seek those willing to fund this project with either one-time gifts or monthly donations.

For more information contact us at (928) 636-1153 or crsvarc@crsvarc.com.

Also visit http://tinyurl.com/nphm2c4 for project updates and details.